SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1912.

GENERAL PHYSICS.

1307. *Dynamometer for the Calibration of Testing Machines.* **E. Sauvage.** (Bull. Soc. d'Encouragement, 117. pp. 789–791, June, 1912.)—The calibration of testing machines by means of test-pieces of standard elastic resistance is unsatisfactory, because of unavoidable discrepancies between test-pieces of the same material and identical in shape and size. Espeut has devised in the French Central Naval Laboratory a calibrating instrument consisting of an elliptical ring of tempered steel which can be fixed between the shackles of a testing machine at the ends of its major axis. Extensions of the major axis are measured to 0·005 mm. by means of a micrometer screw-gauge whose ends rest against the inside of the ring, and are kept in position by brackets attached to the ring. Ring and gauge are thus at the same temperature, and heat effects are eliminated. The gauge is provided with a friction-tight sleeve which yields when the ring contracts under release of load, thus preventing damage to the screw-thread. The ring is machined from a solid piece of steel. Tests show that under widely-varying conditions of temperature elongations remain strictly proportional to loads. The 10,000-kg. machine described measures correctly to 25 kg. The construction of a 50-ton machine is projected. E. J. S.

1308. *Density and Expansion of Aluminium.* **F. J. Brislee.** (Faraday Soc., Trans. 7. pp. 221–227; Discussion and Communication, pp. 227–228, June, 1912. Chem. News, 105. pp. 3–5, Jan. 5, 1912.)—The metal used has about 0·25 per cent. of both iron and silicon. The mean density for cast Al found is 2·708, but worked metal may attain to 2·72. The coefficient of expansion for hard-drawn Al is $24{\cdot}32 \times 10^{-6}$, and for annealed metal $24{\cdot}54 \times 10^{-6}$ between 0° C. and 100° C in each case. All results are obtained from a great number of specimens. In the *discussion*, **R. Seligman** pointed out that 2·67 is the generally accepted figure for the density, 1 or 2 per cent. less than here given. P. E. S.

1309. *The Measurement of Johansson Gauges.* **A. Pérard** and **L. Maudet.** (Comptes Rendus, 154. pp. 1586–1588, June 10, 1912.)—Johansson gauges of length varying from 100 mm. to 1 mm. were measured by being inserted between the faces of other Johansson gauges and were thus measured in the usual way by the method of differences. The gauges were in no case wrong by more than 0·2 micron. Further tests of planeness and parallelism resulted in showing the excellence of the gauges in shape. P. E. S.

1310. *Measurement of Small Gauges by Interference.* **A. Pérard.** (Comptes Rendus, 154. pp. 1798–1800, June 24, 1912.)—Small Johansson gauges, from 5 mm. downwards, are measured by interference bands formed between glass slabs and the gauge surfaces. The errors for 5-mm. gauges average 0·11 μ, and for 1-mm. gauges 0·04 μ. P. E. S.

1311. *Properties of Alloys at High Temperatures.* **G. D. Bengough.** (Inst. of Metals, Journ. 7. pp. 123–174; Discussion and Correspondence, pp. 175–190, 1912. Engineering, 93. pp. 93–95, Jan. 19, and pp. 166–170, Feb. 2; Discussion, pp. 90–91, Jan. 19, 1912. Mech. Eng. 29. pp. 193–195, Feb. 16; 238–242, Feb. 23, and pp. 262–267, March 1, 1912.)—This paper contains the results of a series of tensile tests on selected metals and alloys at temperatures varying from the ordinary temperature to the neighbourhood of the melting-points of the materials used. A special form of testing machine was used, and a full description of it is given in the paper. The materials examined include Cu, Al, Cu-Ni alloy and various brasses. A number of unexpected results were obtained, the curves showing the variation of mechanical properties with temperature, indicating certain mechanical critical points, in the neighbourhood of which the directions of the curves alter rapidly. This phenomenon also occurs in the case of pure Cu and Al. The most abrupt changes in mechanical properties do not occur at temperatures representing phase changes. A theoretical explanation of the shape of the curves obtained is suggested and discussed. C. O. B.

1312. *Official Tests of Iron Bridge-members.* **B. Stock.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1101–1109, July 13, 1912.)—Describes tests made in the new 3000-ton machine recently installed [see Abstract No. 573 (1912)]. The first series was of riveted joints in which the main plates butt and are joined by two coverstraps. Two sets were made; in one the plates were roughened with acid and oiled before riveting, in the other they were further painted with red-lead. Comparative tests were made of joints made by hand, by pneumatic riveter, and by a hand-lever machine. The joint being placed in tension, the movement of the main plates relative to the coverstraps was measured by a simple lever indicator and plotted against the load. A movement is evident in all cases at the smallest loads, the lever-pressed joint shows a distinct "yield" not shown by the other types. The use of red-lead appears to have no influence on the strength of the joint. The lever machine gives in all cases, of various dimensions, a joint which is stronger to resist slip than pneumatic or hand-riveting, the strengths being as 242 : 142 : 100. The loads were in each case carried to fracture; the method of riveting appears to have no influence on the ultimate strength. The slipping resistance is less with two rivets of greater diam. than with three of smaller diam., the total rivet areas being the same. The difference was greatest with hand-riveting and least with the lever machine. The lever machine made heads of better shape and more accurately placed than either of the other processes, though the author does not attribute to this the superiority of resistance to slipping.

The second series of tests relates to joints with three different configurations of 15 rivets, respectively forming an equilateral triangle uniformly mapped out, a rectangular area, and a parallelogram oblique to the axis of the bar. The rivets were of 23 mm., 21 mm., and 23 mm. diam. respectively. It was found that the joints broke in all cases by shearing of the rivets. The form of the configuration has no appreciable effect on the strength of the joint, the max. variation either way being only 5·7 per cent. Owing to shear-yielding of the rivets the tensile strength of the plates seems to be used to the extent of only 88 per cent.

The third series of tests relates to lap-joints and angle-irons and the weakening effect of the rivet holes. In the first case specimens were tested of plates 13·4 cm. wide and containing 4 rivets, 2·3 cm. diam., staggered at various pitches from 5 to 7·5 cm. In the second case the specimens were 22·2 cm. wide, and included 7 rivets alternately single and two abreast, the pitch varying from 4 to 8 cm. Elastic tests were also made of specimens of unbroken material. The results show that for both 4 and 7 rivets the limit of proportionality is less than that of the full plate as long as the pitch is less than 6 cm. When the pitch exceeds 6 cm. the elastic limit exceeds that of the full plate and continues to increase with the pitch. In all cases except one both plates in the joint broke along the same line or lines, the direction being oblique for pitches below 6 cm. and at right angles to the axis for greater pitches. The effect of rivet holes on angle-irons was next investigated. Each specimen contained two rivet holes, 2·1 cm. diam., one in each arm 5 to 5·5 cm. from the angle, and the pitches varied from 4 to 6·5 cm. In one set the holes were left empty, in the other the holes were riveted up with plates, 8 cm. × 1 cm., under the heads. The results show that for angles without rivets the pitch of the holes has no definite effect on the elastic limit. The ultimate strength is smaller than that of the full angle with pitches below 5·5 cm., when fracture always occurs along an oblique transverse line. At higher pitches, when fracture occurs along a line normal to the axis, the ultimate strength exceeds that of the full angle. This distinction holds for both elastic limit and ultimate strength in the case of the riveted angle. In the latter case the difference is small for the breaking strength, but quite considerable for the elastic limit; the strength of the small plates riveted on must not be overlooked in this case. The last tests relate to four angle-iron members. Each is built up of two main plates joined at their butting edges by four angle-irons; in two cases the 4 angles are riveted up direct, in the others a transverse plate is interposed before riveting. In all cases the plates show slipping at quite small loads, the yielding is the same for all four specimens up to 20 tons. The transverse plate has no appreciable effect on ultimate strength, the breaking loads being 63,090 kg. and 63,990 kg. respectively. At smaller loads, up to 20 tons, the bending of the angle-iron arms was less for the specimen without transverse plate than for the member with one. Photographs are given of the two types after fracture. Failure has in both places taken place by the rivets in tension.

E. J. S.

1313. *Torsional Oscillations of Magnesium Wire.* **G. P. Seaman.** (Roy. Soc. Edinburgh, Proc. 32. 3. pp. 247–250, 1911–1912.)—Previous experiments have shown that the equation $y^n(x + a) = b$ holds very exactly for wires of different materials, where $y =$ range of oscillation, $x =$ number of oscillations, and n, a, and b are constants depending on the metal under the given conditions. Investigation of the effect on these constants of subjecting Mg wire to various conditions, shows that rotational or extensional strain in the unheated condition does not appreciably alter them, nor does heating the wire, until a temperature of about 850° C. is reached; above this temperature n falls continuously with increase of temperature in the case of small oscillations, but for large oscillations it rises at first and then falls. The constants are practically unchanged after immersing the wire in liquid air. [See Abstracts Nos. 1810, 1811 (1911).] W. H. Si.

1314. *Non-turbulent Air Currents.* **C. Retschy.** (Motorwagen, 15. pp. 207–218, March 31; 240–246, April 10; 388–393, May 31; 463–468, June 30, and pp. 524–528, July 31, 1912.)—All rotating apparatus produces turbulence in the air, and this has a pronounced effect on the resistance of the air. In order to eliminate it, the measurements must either be made in a tunnel through which the apparatus is rapidly transported, or a non-turbulent air current must be artificially produced. This may be done by means of a long tube provided with transverse screens of netting and fabric, followed by another tube ending in a diaphragm having about half the aperture of the tube. The stream just outside the diaphragm is very approximately non-turbulent even at velocities of 4 m./sec., such as are used in flying. This is proved by mixing smoke with the air in narrow streaks, the smoke being brought into the air current by means of small tubes with stream-line surfaces. The velocities were measured by a hot-wire anemometer, having a single Pt hot-wire instead of two nickel wires as in the Siemens-Halske instrument. E. E. F.

1315. *Velocity of Air Currents.* **U. Bordoni.** (N. Cimento, 3. pp. 241–283, April, 1912. Paper read before the Italian Physical Soc., Jan. 20, 1912.)—Describes a method of measuring wind velocities which does not introduce appreciable disturbances into the air filaments. It consists of a wire forming one branch of a Wheatstone bridge, and heated either by an alternating current or an intermittent current. The speed of the wind is measured by the lowering of the temperature of the wire, which in turn is indicated by its reduced resistance. E. E. F.

1316. *Experimental Basis of Relativity Principle.* **M. La Rosa.** (N. Cimento, 3. pp. 345–365, May, 1912.)—Of the two assumptions on which the relativity principle is based, the first, which postulates the invariance of optical and electrical phenomena with "absolute" motion, may be taken as experimentally established in a negative sense, no experiment contradicting it having as yet been made. The second assumption, viz., that the velocity of light is the same in a moving system and a system at rest, still awaits confirmation, astronomical data being insufficient to decide for or against it. The author suggests a modification of the Michelson-Morley experiment which may discriminate for or against the second assumption. The time of propagation of waves along the two branches of the apparatus must be equal whether the source of light is terrestrial or extra-terrestrial, according to the relativity principle. According to Galilean mechanics, they are only equal if the source participates in the earth's motion. Otherwise, the difference depends upon the velocity of waves reflected by a mirror and upon the refractive indices of the media filling the two branches. E. E. F.

1317. *Free Fall.* **M. Abraham.** (Real Istit. Lombardo, Rendiconti, 1912. Phys. Zeitschr. 13. pp. 310–311, April 15, 1912.)—In a recent paper [Abstract

No. 785 (1912)] the velocity of light c is connected with the gravitational potential Φ by the relation $(c^2/2)-(c_0^2/2)=\Phi-\Phi_0$. The present paper deals with free fall in space containing a homogeneous gravitational field. The equations of motion are the same as those of Galilean mechanics, except that the time is replaced by the "local time" (*Eigenzeit*) of the falling particle. The gravitational potential is referred to a plane $x=0$. Thus $\Phi_0=0$, $\Phi=-gx$ and $c^2=c_0^2-2gx$, where c_0 is the velocity of light for $x=0$. The velocity of fall becomes $c_0 \sin(gt/c_0)\cos(gt/c_0)$, and the height fallen through becomes $(c_0^2/2g)\sin^2(gt/c_0)$. These are only valid for $gt < e_0 \pi/2$. Since the fundamental relation first stated imposes the condition $\Phi_0-\Phi < c_0^2/2$, the existence of a homogeneous infinite gravitational field is excluded. The author draws some conclusions of cosmogonic interest: For a star of mass m and radius a, $\gamma m/a < c_0^2/2$ (where $\gamma=$ gravit. const.). It follows that the mass of a star of the same mean density as the sun cannot exceed 100 million times the mass of the sun (or, approximately, the mass of our galactic system). E. E. F.

1318. *Conservation of Energy and Matter in Gravitational Fields.* **M. Abraham.** (Accad. Lincei, Atti, 21. pp. 432–437, April 14, 1912. Phys. Zeitschr. 13. pp. 311–314, April 15, 1912.)—Treats the conservation of mass and energy on the basis of Minkowski's dynamics and the elasticity theory of Herglotz [Abstract No. 29 (1912)]. If a quantity of energy at rest, E_0, is taken from a gravitational potential Φ_0 to a superior potential Φ, it increases in amount, the new quantity being $E=E_0 c/c_0$ [see preceding Abstract]. This may be interpreted, with Einstein, by attributing to energy a gravitational mass equal to the energy at rest divided by the square of the velocity of light. What remains constant is E/c, and the "conservation of matter" means that the product mc remains constant. The two laws may therefore be put in the form $mc=E/c=$ constant. E. E. F.

1319. *Acceleration of Pilot Balloons.* **L. Schiller** and **A. Döge.** (Phys. Zeitschr. 13. pp. 234–240, March 15, 1912.)—Balloons having a sectional area of 0·17 m.^{2} were allowed to ascend freely in a glass-covered yard 35 m. by 14 m. wide and 11 m. high. They were photographed every half-second by two cameras whose axes were at right angles to each other. The positions were afterwards determined from the negatives by means of a Zeiss comparator. The object of the measurements was to find whether the balloons ascended according to Stokes' law (resistance $\propto$ velocity); Allen's law (resistance $\propto v^{1\cdot5}$); or Newton's law (res. $\propto v^2$). It was found that for velocities ranging from 0·2 to 0·8 m./sec. the exponent was 1·57. At 0·87 m./sec. it was 1·76, and at 1 m./sec. it was 2. At this last speed, therefore, the "turbulent position" sets in, and Newton's law is obeyed. The air-resistance may be put $=rqv^{1\cdot5}$, where q is the sectional area and r the specific air-resistance, in this case $=0{\cdot}035$ kg. sec.^{2}/m.^{4}. A special investigation of the acceleration tends to show that some of the stream-lines produced by the balloon contribute to its own acceleration. E. E. F.

1320. *Theory of Gravitation.* **G. Jaumann.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 95–182, Jan., 1912.)—Poisson's differential equation for the gravitational field, $4\pi\kappa\rho=\operatorname{div}\nabla\chi$ (where k is the gravitational constant, ρ the density, and χ the gravitational potential) is nothing but a differential form of a law of action at a distance, viz., Newton's law. It may be brought more into accordance with physical principles by adding a term representing a time rate. The author's form of the law is div $\nabla\chi = 4\pi k\rho + \alpha\, d\chi/dt$, where α is a very small quantity. In the interstellar ether ρ is nearly zero, and hence in that case $\nabla\chi = \alpha\, d\chi/dt$. In the ether, therefore, the gravitational potential or "gravial" χ obeys a law of the same form as the temperature in a conducting medium. Disturbances of the gravial are transmitted, not as waves, but in a manner analogous to temperature-changes, though very rapidly. The author works out a new theory of gravitation on this basis, and applies it to the questions of the stability of the distances of the planets from the sun, their eccentricities, and the motion of perihelia, as well as to terrestrial variations of zenith and latitude. E. E. F.

1321. *The Static Gravitational Field.* **A. Einstein.** (Ann. d. Physik, 38. 2. pp. 443–458, May 23, 1912.)—The author deduces the following fundamental electromagnetic equations for a static gravitational field from the "principle of equivalence":—

$$v\rho + \partial E/\partial t = \mathrm{rot}\,(cH),\ 0 = \mathrm{div}\ H \qquad \partial H/\partial t = -\mathrm{rot}\,(cE),\ \rho = \mathrm{div}\ E,$$

where t is the time measured in a uniformly accelerated system K; v is the velocity of electricity measured with time t and lengths referred to scales at rest in the system K; ρ is the density of electricity, measured in electrostatic units in the usual way in a system free from acceleration, except that the unit of time is the time required by light to traverse 1 cm. E is the electric field vector, measured by reference to a spring in a non-accelerated system and the above time-unit. A similar definition applies to the magnetic field vector H. The equations may be taken as exact, however much the gravitational potential c may vary from point to point. But they do not take into account a possible influence of the electromagnetic field on the gravitational field. E. E. F.

1322. *Ring Theory of the Atom.* **A. C. Crehore.** (Phys. Rev. 34. pp. 241–257, April, 1912.)—A method of calculating atomic weights is based upon the assumption that the gravitational attraction of the atoms of the different elements may be obtained by adding together the attractions and repulsions of the earth for the constituent parts of each atom, namely, the positive electricity and the individual negative corpuscles revolving in rings within the positive electricity [Abstract No. 964 (1904)]. If there is only one electron at the centre of the positive sphere, the atomic weight is zero. It is suggested that such an atom may be an atom of ether. E. E. F.

1323. *Shape of Ultra-microscopic Gold Particles.* **R. Gans.** (Ann. d. Physik, 37. 5. pp. 881–900, April 16, 1912.)—Mie [Abstract No. 594 (1908)] has calculated the absorption curve of colloidal gold solutions on the assumption that the particles have a spherical shape. He showed that quite small particles give ruby-red solutions, whereas large ones give greenish-blue. It is assumed that the refractive index and absorption coefficient are the same as for metallic gold. The author extends the calculation by generalising the shape of the particles into an ellipsoid of rotation, which may be either prolate or oblate. He shows that as soon as the spherical shape is departed from, the curve of absorption moves towards the less refrangible end of the spectrum, whether the sphere is flattened or elongated. It follows that most colloidal gold solutions must have very approximately spherical particles. The exceptional blue solutions observed by Steubing, in which the particles are also very small, must contain particles of a markedly ellipsoidal shape.

E. E. F.

1324. *Molecular Cohesion.* **A. P. Mathews.** (Science, 36. pp. 92–95, July 19, 1912.)—The product M^2K of the square of the cohesive mass of a molecule into the cohesion constant, is equal to the constant $2{\cdot}97 \times 10^{-37}$ multiplied into the 2/3 power of the product of the molecular weight W into the number V of valencies in the molecule. This relation, probably universally true, gives a means of computing valencies when the critical data are unknown. Van der Waals' constant *a* can be computed for non-associating substances whose valency is known by the formula $a = 2{\cdot}97 \times 10^{-37} (WV)^{2/3} N^2$, where N is the number of molecules in the volume taken. A table is given of 19 substances showing the constancy of the ratio $MK^2/(WV)^{2/3}$, after determining MK^2 from the surface tension. If the relation holds generally, nearly all organic chlorine compounds will have to contain trivalent Cl. Sulphur, generally hexavalent, would have to be the same in CS_2, but quadrivalent in SO_2. The relation implies, on the electronic theory, that the electrons of the atoms and those of the valencies cannot be summed, and that cohesion is proportional to their product, as assumed in Drude's theory of refraction and dispersion. It also tends to support Sutherland's view that cohesion is of a magnetic nature. E. E. F.

1325. *Molecular Attraction in Liquids and in Liquid Films.* **M. M. Garver.** (Journ. Phys. Chem. 16. pp. 471–474, June, 1912.)—The author justifies, by reference to the laws of Newton and Maxwell, his conclusion that the tensile strength of liquid films is independent of the mass of the attracting molecules constituting the film—a conclusion which he deduces from the equations $w/\sigma = R/m \,.\, T = -\gamma/\tau\rho$, where ω is the vapour pressure, σ the vapour density, R the general gas constant, m the molecular weight, T the absolute temperature, γ the surface tension, ρ the liquid density, and τ the thickness of the liquid film. [See also Abstract No. 992 (1912).]

W. H. St.

1326. *Vertical Movements of the Eiffel Tower.* **C. E. Guillaume.** (Comptes Rendus, 155. pp. 26–29, July 1, 1912.)—The small variations in the height of the second stage of the Eiffel Tower, at a height of 116 m. above ground, were recorded by means of an invar bar attached at one end to the ground, at the other to an arrangement of levers at the 116-m. level, with weights designed to keep the bar under a definite tension. The motion of one end of one of the levers was a measure of the vertical movement at the second stage, and was recorded in the usual way by attaching to it a pen which made a trace on a piece of paper attached to a rotating drum. The motion of the pen was damped by means of a dashpot containing thick oil. It was found that the greatest variations of temperature of the air produced changes in the height of the 116-m. stage of from 2 to 3 cm. A diagram for June 8–9, 1912, compares the recorded variations at 116 m. with the thermograph giving air temperatures near the ground. The two curves are closely parallel to one another, a range of air temperature of 6·7° C. corresponding with a change in the length of the part of the tower considered of 14 mm. Wind influences the curves, because each gust deflects the invar bar from rectilinearity, and "embroiders" the record. The true undisturbed curve can easily be distinguished, because it forms one edge of the embroidery.

R. C.

1327. *Hail and Hoar-frost on Mont Blanc.* **J. Vallot.** (Comptes Rendus, 154. pp. 1650–1652, June 10, 1912.)—Hailstones up to 35 mm. in diam. and weighing 15 gm. have been observed on Mont Blanc. The hailstones usually fall in a calm interval between two periods of strong wind. Hoarfrost is frequently deposited during storms. It is formed most abundantly on corners and sharp edges, and the deposit is made up of crystals with their long axes pointing towards the direction from which the wind is blowing. The deposit itself grows towards the same direction. R. C.

1328. *Graphical Determination of Seismic Epicentres.* **G. W. Walker.** (Meteorological Office, Geophysical Memoirs, No. 3. pp. 53–54, 1912.)—A Galitzin installation at a single station (lat. ϕ, long. λ) gives the distance of the epicentre D, and the azimuth α. From these data the author shows how the latitude and longitude of the epicentre may be easily and rapidly obtained, correct to a few minutes of arc, by a graphical method. The construction is made by a stereographic projection of the earth's surface on the plane of the equator, every circle on the sphere projecting into a circle on this plane. A. D. R.

1329. *Earthquake of January* 24, 1912, *in the Ionian Islands, and its Velocity of Propagation.* **G. Agamennone.** (Accad. Lincei, Atti, 21. pp. 646–652, May 19, 1912.)—From a comparison of the records from 26 different European observatories, it is concluded that the time of the epicentre of the disturbance was 4h. 23m. 12s. p.m. and that its rate of propagation was 7·68 km. per sec. W. H. Si.

1330. *Earth Tides.* **T. Shida.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 16. pp. 242–258, May, 1912.)—The author has by means of horizontal pendulums at Kamigamo Observatory, Japan, investigated the elasticity of the earth's crust for the tilting of the ground caused by the loading and unloading of oceanic tides. The observed deflections are produced by (1) the direct tide-generating force of the moon, (2) the tilting of the surface of the earth as effect of the body tide produced by it, (3) the change in the direction of gravity due to the earth's tidal deformation, (4) the attraction of the tidal waves of the ocean, (5) the tilting of the ground due to variation of the load of sea water, (6) the change of direction of gravity due to the deformation of the earth's crust caused by the ocean's tidal load. All these components superpose within the same period, and in order to separate them many assumptions have to be made. Doing so, the author obtains, on assumption of Wiechert's law of density within the earth, an effective rigidity of $12{\cdot}7 \times 10^{11}$ c.g.s. units. This, while twice as great as the value generally estimated from tidal observations and deflections of the plumb-line, is in harmony with Herglotz's value of $11{\cdot}7 \times 10^{11}$ derived from the Chandler period of free nutation. It also gives reasonably accurate values for the velocity of propagation of the second preliminary tremors of a seismic disturbance. A. D. R.

1331. *Graphical Determination of Seismic Epicentres.* **C. Zeissig.** (Phys. Zeitschr. 13. p. 767, Aug. 15, 1912.)—The position of the epicentre E may be obtained by the intersection of two lines (approximately straight) given by the times T_1, T_2, T_3, of commencement of the disturbance at stations S_1, S_2, S_3. Assume a distance d_1 for ES_1 less than the true value. Calculate $d_2 = d_1 + \delta$ for ES_2 from the difference of times $T_2 - T_1$ and the "distance-time" seismic propagation curve. This gives a point E_1 for the epicentre. Similarly obtain a point E_2 by taking a value D_1 for ES_1 which is too large. The real epicentre E lies approximately on the line E_1E_2. A second line containing the E is obtained by employing the observation of station S_3 and so the epicentre is uniquely determined. A. D. R.

1332. *Ex-Meridian Altitudes of Stars.* **G. Guglielmo.** (Accad. Lincei, Atti, 21. pp. 404–410, March 17, 1912.)—A method is described of timing accurately the instant at which two stars of approximately the same declination attain the same altitude. A mirror is suspended in a vertical plane in such a manner that it observes half the area of the object-glass of the telescope. Its surface makes a small angle with the axis of the telescope. Two stars of the same altitude, but of slightly different azimuths, may be brought into coincidence by suitably adjusting the azimuth of the mirror. Conversely, when two such stars are observed in this manner, the moment at which they attain the same altitude is marked by their coincidence. The altitudes of stars may thus be compared with those of Polaris. If the mirror is suspended on a horizontal instead of a vertical axis, the moment at which two stars attain the same azimuth may be observed. Details of the construction as carried out at Cagliari are given.
E. E. F.

1333. *Determination of the Depth of the Milky Way.* **T. J. J. See.** (Amer. Philosoph. Soc., Proc. 51. pp. 1–17, Jan.–March, 1912.)—The method of annual parallaxes for the determination of distances can only be extended to stars within less than 100 light years of the sun. Investigations in distances up to 1000 light years can be made in the case of binary stars by the spectroscopic application of Doppler's principle, but double stars are rare among the star clouds of the Milky Way, and cannot be separated. W. Herschel estimated the distances of stars by their relative visibility. He calculated that his telescope brought stars to within 1/75 of their actual distances; and that a star equal in brightness to one of the 1st magnitude, but 750 times more remote, would appear in his telescope as a 6th magnitude star. Taking α Centauri as a standard at 4·5 light years, Herschel ascribed 3375 light years to those stars visible as of the 6th magnitude in his telescope, on the assumption of equal brilliancy. From recent data in the Lick Observatory Bulletin, it appears that the average distance of 225 helium stars is 540 light years. Campbell's observations on 180 stars resembling our sun showed their average cross motion to be 0·11″ of arc per annum, and their average velocity in the line of sight 8·9 miles per sec.; assuming the average velocities in both planes to be the same, these star distances work out at 92 light years. The author supports Herschel's original estimate of 2,000,000 light years, or more, against 2000 to 70,000 given by later authorities as the distance of the most remote stars. He also reasons that the thickness of the Milky Way is about 21,600 light years, and its depth over 1,000,000, the latter figure agreeing with Herschel's of over 100 years ago. A coefficient of light extinction of 0·999 is adopted as best harmonising with all known phenomena. With a telescope of 12 ft. aperture important discoveries in the Milky Way might be anticipated. H. F. H.

1334. *Variations in the Spectrum of Nova Geminorum* (2). **V. Fontana.** (Accad. Lincei, Atti, 21. pp. 765–768, June 16, 1912.)—Thirteen photographs were made of the spectrum of the Nova at Catania, from March 21 to May 7. A prismatic camera attached to the photographic equatorial with a Zeiss Petzval objective, and a Schaer prism of 11 cm. diam. were employed. The determinations of wave-lengths of the various lines were made by a graphic method, referred to the principal easily recognisable hydrogen lines, and so were only approximate. At first the spectrum of the bright lines was essentially that of the principal hydrogen lines, D_3 of helium, K of calcium; later very faint, those of hydrogen and varying much in shape and intensity.

They did not in general extend beyond H_ζ, but H_η appeared in the spectrum of March 23, and on March 25 H_ι also was seen. H_α was at first very faint, but then increased in brightness as the colour of the star varied; which was at first orange and later deep red. H_β was always distinct: at first fainter than H_γ it became gradually brighter, and on April 12 it appeared double as though divided by a very faint absorption line. H_γ very bright and broad at first, varied much in these respects later. Its duplicity was suspected on March 28 and certain on April 12, on the 15th it appeared triple. H_δ also underwent similar variations, as was the case with H_ϵ. The latter line was not visible on the plates of April 22 and May 7. The line *b* appeared only on March 25 and April 2, and the "nebular" line $\lambda = 501$ was present on 5 plates. The second nebular line was doubtful, but the line $\lambda = 492$ was broad and well defined, as was the line $\lambda = 423$ of calcium. The bright line $\lambda = 464$ noticed by Tikhoff on the Pulkowa photographs of March 17, and very distinct in the spectrum of Nova Lacertæ, 1911, was seen. This increased considerably in brilliancy, being as bright as H_δ on March 27, and became the brightest of all on May 7. The bright hydrogen lines were from the beginning accompanied by absorption lines on the violet side of each; these varied also in intensity, the best defined of these being that by H_δ. Other well-defined lines were at $\lambda = 460$, $\lambda = 445$, $\lambda = 419$, and $\lambda = 414$. The regions of the spectrum between $H_\beta - H_\gamma$ and $H_\gamma - H_\delta$ were especially rich in bright and dark lines. [See Abstract No. 1008 (1912).] F. W. H.

1335. *Bending of Curved Tubes.* **H. Lorenz.** (Phys. Zeitschr. 13. pp. 768–774, Aug. 15, 1912.)—The treatment is entirely mathematical.

1336. *Elements of a Kinetic Theory of Crystals.* **J. Beckenkamp.** (Soc. franç de Minéralogie, 34. pp. 1–55, Dec., 1911.)

1337. *Motion of Solids in Viscous Fluids.* **U. Crudeli.** (N. Cimento, 3. Ser. 6. pp. 449–456, June, 1912.)—Mathematical.

1338. *Lecture Experiments on Surface Tension.* **F. B. Kenrick.** (Journ. Phys. Chem. 16. pp. 513–518, June, 1912.)—Describes seven experiments:—(1) Mechanical model. (2) Two drops. (3) Surface tension and solubility. (4) Surface concentration in saponin solution. (5) Surface concentration of methyl-violet solution. (6) Emulsification of oil by potash. (7) Oil films on water. L. H. W.

1339. *Laboratory for Radio-active Measurements.* **J. Danne.** (Phys. Zeitschr. 13. pp. 565–574, June 15, 1912.)—The paper gives a detailed description of a new laboratory at Gif (Seine-et-Oise), of which the author is director. E. M.

1340. *Seismic Records obtained at the Samoa Observatory*, 1909–1910. **K. Wegener.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 267–384, 1912.)—The discussion of the observations requires reference to the tabulated results for its satisfactory comprehension, and therefore the original pages should be consulted by those interested. L. H. W.

1341. *Photometric Estimation of Stellar Magnitudes.* **K. Popoff.** (Comptes Rendus, 154. pp. 925–926, April 9, 1912.)—Account must be taken of the regional luminosity in determining stellar magnitudes by photometric comparisons, and this will differ according as the observations are photographic or visual. Formulæ are given introducing corrections for allowing for these differences. C. P. B.

LIGHT.

1342. *Infra-red Spectrograph.* **P. Lebedew.** (Phys. Zeitschr. 13. pp. 465–468, June 1, 1912.)—The apparatus, constructed for the Physical Department of Moscow University, is intended for absorption measurements up to 15000 mm. To avoid disturbances by diffused light, there is a double dispersion. Light from a Nernst lamp is caught on a mirror, and concentrated on a wide slit at the focus of a mirror of 50 cm. focal length. The parallel beam falls on a rock-salt prism with a silvered face, which reflects it after two refractions on to another mirror, which, in turn, throws a spectrum on a narrow slit. This process is repeated by another pair of mirrors and prism, and finally the beam is focused on the junction of a vacuum micro-radiometer, whose deflections are observed or photographed. The vacuum mounting increases the sensitiveness by reducing the damping and increasing the temperature of the junction. The zero is adjusted by attaching a Bi needle to the suspension and letting it swing between soft-iron pole-pieces. These can be magnetised by approaching a magnet to them, and thus a variable degree of force may be exerted on the suspension. The greatest difficulty encountered was the sensitiveness of the apparatus to mechanical vibrations. E. E. F.

1343. *Simple Demonstration Apparatus for the Infra-red Spectrum.* **A. Trowbridge.** (Science, 35. pp. 931–933, June 14, 1912.)—The standard detecting instruments, such as the bolometer, thermopile, radio-micrometer, are not well suited for use in the lecture-room, where great stability is not usually ensured. The author has designed a simple apparatus for demonstration purposes, consisting of a rubber band, a glass fibre, a small mirror, and a small piece of plate glass. An india-rubber band, AC, about 1 mm. wide, is stretched to nearly double its length on the rectangular frame of plate glass, and a small glass fibre, as straight as possible and just stiff enough to support a small mirror at its end, is placed under the middle of the band at its middle point B, so that the fibre is at right angles to the band. The end carrying the mirror projects beyond the edge of the glass plate. The mirror is about 2 or 3 mm.^{2} in area, and is made from a silvered microscope cover-glass. If the portion AB of the rubber band be heated, the fibre will roll on the frame towards A, and a beam of light reflected from the mirror will indicate the amount of this contraction, the scale, of course, being arbitrary. A change of temperature of both portions of the band, AB and BC, will be without effect on the position of the mirror, so that a steady zero is ensured. The inertia of the moving parts is small, and the change in the elasticity of the rubber follows the changes of temperature without any very noticeable lag, so that the instrument is both dead-beat and sufficiently quick to respond to *differences* in temperature between the sections AB and BC. For use as a substitute for the bolometer the glass plate is clamped in a vertical plane and the spectrum caused to pass across the portion AB. The deviation in the beam of light from the mirror is approximately proportional to the energy present in the particular part of the spectrum which covers the strip. For demonstration in the region between the red and $\lambda = 3\mu$, where glass begins to be opaque, a Nernst lamp may be used with two large short-focus lenses and a prism between to give a rough spectrometer arrangement. It is easy to show that the max. deviation of the mirror is reached when no visible light is falling on AB. A. W.

1344. *Use of Maltese Cross in Kinematograph Apparatus.* **C. Forch.** (Zeitschr. Instrumentenk., Beib. 12. pp. 121–128, June 15, 1912.)—Describes at length an arrangement of two rotating discs designed for use with kinematograph projection apparatus. One of the discs is shaped like a Maltese cross, and the other is circular with the piece enclosed between the circumference and a circular arc through the ends of two perpendicular diameters removed. A peg carried by the circular disc engages with the slots in the Maltese cross, which thus moves in jerks, making one complete revolution to four of the circular disc. The whole constitutes a shutter, the time during which it is open and the rate of opening and closing depending on the shape of the various parts. Tables are given showing the relative size of opening for various dimensions at different intervals. From these the most suitable dimensions are deduced. A. W.

1345. *Experiments on an Incandescent Standard of Light.* **W. A. Harwood** and **J. E. Petavel.** (Roy. Soc., Proc. Ser. A. 86. pp. 409–410, April 25, 1912.)—Describes an attempt to construct an improved incandescent platinum standard. A strip of the metal is heated electrically. Its temperature of incandescence is controlled by the aid of two thermopiles connected in opposition. In front of one of these is placed a plate of fluorspar, which transmits radiation of long wave-length, and before the other a water cell, which absorbs such energy. At a certain temperature the two thermopiles counteract each other, and this point is readily reproducible. The accuracy is within ± 0·5 per cent. But the standard is not portable, the intensity low, the colour unsatisfactory, and the adjustment requires much care and skill. From a practical standpoint these defects seem to outweigh the advantage as regards accuracy. J. S. D.

1346. *Measurement of Transparency.* **M. M. Feldstein.** (Journ. Phys. Chem. 16. pp. 421–422, May, 1912.)—A general description of the Friedburg absorptiometer has previously been given [Abstract No. 537 (1910)]. The present paper gives simple theory. The opaque object A, the polariser B, and the analyser C are arranged in the order A B C. If E is the intensity of the light transmitted by the opaque body, I the intensity of the light transmitted by the analyser, and ϕ the angle through which the analyser is turned from the initial position of max. light, we have by the law of Malus $I = E\cos^2\phi$. In comparing the transparency of two objects, each time the analyser is turned to a point where further darkening is imperceptible. Hence $E_1\cos^2\phi_1 = E_2\cos^2\phi_2$. Assuming the intensity S of the source of light to remain constant, we have at once $S/E_1 : S/E_2 = \cos^2\phi_1 : \cos^2\phi_2$. But the ratio of the intensities of the impinging and transmitted light is the definition of transparency; hence the transparencies of two objects are in the ratio of the squares of the cosines of the angles through which the analyser is turned from the position of max. light to that where further darkening is imperceptible, the intensity of the incident light remaining constant. A. W.

1347. *Indices of Refraction of Japanese Topaz.* **S. Nakamura.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 15. pp. 230–234, April, 1912.)—

Describes experiments with a polarisation spectrometer of Voigt's type on prisms of Japanese topaz, showing that it is a positive biaxial crystal, whose axial angle V is given by $2V = 68^\circ 48{\cdot}1'$. The three indices of refraction found are $\alpha = 1{\cdot}6110$, $\beta = 1{\cdot}6187$, and $\gamma = 1{\cdot}6209$. A. W.

1348. *Selenium Photometry.* **A. H. Pfund.** (Phys. Rev. 34. pp. 370–380, May, 1912.)—The selenium photometer will yield accurate results under the following conditions: Monochromatic light must be used; an accurate sensibility curve for the various wave-lengths must have been established; and exposures to light must be made automatically and must be of short duration. The last condition may be secured by cutting a sector of 70 deg. out of a circle and mounting it on the seconds hand of a clock. Talbot's law holds throughout the visible spectrum, so that the incident energy may be cut down by a rotating sector giving 10 to 60 interruptions per sec. For wave-lengths from 450 to 650 $\mu\mu$ the galvanometer deflection varies as the square root of the incident light, while for wave-lengths λ700–830 $\mu\mu$ it varies as the light. Hence the sensibility curve for the spectrum alters with the intensity of the light. In very faint light, the maximum of sensitiveness is in the yellowish-green, whereas for intense light it is in the red. E. E. F.

1349. *Radiant Efficiency of Incandescent Filaments.* **W. E. Forsythe.** (Phys. Rev. 34. pp. 333–344, May, 1912. Electrical World, 59. pp. 1318–1319, June 15, 1912. Abstract.)—The author distinguishes between radiant and luminous efficiency, and analyses some of the errors which have occurred in previous investigations, a table being given of the results obtained by other workers. In conclusion he describes his researches on the temperature and radiant efficiency of carbon and metal filaments, and shows that these agree well with those of previous investigations. The radiant efficiency in the four cases is as follows: Tungsten, 5·2 %; tantalum, 4·3 %; "Gem" (graphitised), 3·2 %; carbon, 2·5 %. J. S. D.

1350. *Wave-length and Photochemical Reactions.* **D. Berthelot** and **H. Gaudechon.** (Comptes Rendus, 154. pp. 1597–1600, June 10, and 155. pp. 207–210, July 16, 1912.)—Photochemical reactions are, according to M. Berthelot (1865), either exothermic, irreversible, catalytic, spontaneous, and only accelerated by light; or endothermic, reversible, and depending upon the light energy. Like heat light has therefore a double effect. Reviewing the various photochemical reactions which they have described, the authors point out that the reactions cannot be traced back to the thermal equilibrium, which would correspond to the temperature of the radiating source. The efficacy of the radiations increases with the wave frequency, which plays the part of potential or of photochemical temperature. Endothermic reactions in particular, which are thermally caused only by very high temperatures, require the application of the extreme ultra-violet rays which have been studied, 0·20 to 0·15 μ; shorter waves are too readily absorbed by the atmosphere, and therefore unsuitable for observation.
H. B.

1351. *Photographic Photometry and the Measurement of Densities.* **F. F. Renwick.** (Photographic Journ. 52. pp. 250–258 and 260–262; Discussion, pp. 258–259, June, 1912.)—A brief historical sketch of the subject is given together with a criticism of Brush's result, in which he claims to have shown that the photographic action grows after exposure for about 20 minutes, and the aftergrowth amounts to 8 or 10 per cent. of the whole. In a table are given the values of standard densities as measured in a Martens' polarisation photometer, first without opal in contact with film, and secondly with it, Callier's $D_{\parallel}$ and $D_{\#}$ respectively. Values marked D_ϕ deduced from exposures through them upon Ilford ordinary plates are also added. These values lie between $D_{\parallel}$ and $D_{\#}$, so that $D_\phi = 0{\cdot}71\ D_{\parallel}$, while $D_\phi = 1{\cdot}17\ D_{\#} + 0{\cdot}025$, It is at first suggested that the differences between the values of D_ϕ and $D_{\#}$ are connected with the differences between white opal and a silver-bromide emulsion film as reflecting and diffusing media, but a reconsideration of the experimental conditions leads to the conclusion that the factor 1·17 is a direct measure of the failure of the plates used to obey the Bunsen-Roscoe reciprocity law, and is the quantity 'q' in Schwartzschild's equation. The method adopted for determining D_ϕ assumes the validity of the Bunsen-Roscoe law, for the ratio of the times of exposure necessary to produce equal densities under the negative and on the bare plate are taken to be the inverse of the ratio of the light intensities acting. A. E. G.

1352. *Possibility of Stereoscopic Projection of White Pictures, without Prisms.* **O. Wiener.** (Zeitschr. wiss. Phot. 11. pp. 18–20, April, 1912.)—The idea suggested is an extension of the well-known experiment by which two monochromatic images, red and green, on a white ground, are combined stereoscopically by viewing them through a pair of spectacles with one red and one green glass. In place of two monochromatic images, it is proposed to use what may be called two complementary whites. The spectrum is to be divided into a series of strips, and one kind of white is to be composed of the odd strips, the other of the even strips. The process of forming a white of this kind is probably best performed mechanically, by placing stops in the focal plane of a spectroscope, and recombining those radiations which pass between the stops. An approximation to what is required may be obtained by aid of a selenite crystal plate, not too thin, placed between crossed nicols. A very thin plate will appear coloured; if thick enough it will appear white, but spectroscopic analysis will show that there are blanks in the spectrum at the places of minimum interference. By rotating one of the nicols through 90°, the positions of the minima and maxima are interchanged. Some experiments on the latter lines did not, however, yield very satisfactory results. The red and green spectacles may be replaced by a twin polarising apparatus, each half of which is furnished with a pair of nicols, having a selenite plate between them, the nicols in front of one eye being crossed, and those in front of the other parallel. A. E.

1353. *New Bodies showing Magnetic Double Refraction. Molecular and Atomic Anisotropy.* **A. Cotton** and **H. Mouton.** (Comptes Rendus, 154. pp. 930–933, April 9, 1912.)—The authors explain magnetic birefraction of aromatic liquids on the hypothesis that the molecules of these substances are optically anisotropic, and tend to orient themselves in a magnetic field. In a previous note [Abstract No. 1022 (1912)] they discussed the relation of the phenomenon to chemical constitution, and indicated that certain atoms or groups systematically increase or diminish the specific birefraction of benzene or analogous liquids. To interpret this action, the authors assume that the said atoms or groups possess in themselves a certain magnetic and optic anisotropy, so that these atoms tend to flavour the orientation of the molecule to which they attach themselves, and to reinforce its optic anisotropy. To test the assumption they have extended the research to compounds of carbon, and now find that, while many of these are inactive, those which contain the groups which were active in the aromatic substances show magnetic birefraction. The derivatives containing $—NO_2$ or $—CO—$ give a positive result, viz., nitromethane, chloropicrine, acetone, &c. Those containing I, Br, or Cl give a negative result, *e.g.*, chloroform. Still guided by the hypothesis, the next step was to inquire whether the very active atoms and groups would give magnetic birefraction to molecules deprived of carbon. The group NO_2 being that whose specific action was most marked, the non-organic liquid azotic acid, NO_3H, was tested in the field. It showed positive birefraction. The experiments were made with a small electromagnet, and the specific birefractions found were very feeble. With a powerful electromagnet at disposal, it seems probable that similar magneto-optical researches could be extended to a very great number of substances, organic or mineral, and might furnish data concerning, not only the molecules, but the groups of which they are constituted, and the atoms themselves. Examination of rotatory power determines whether the molecule possesses a plane of symmetry; electric and magnetic birefractions reveal the existence and importance of certain privileged directions. A. E.

1354. *Radiometric Investigation of Water of Crystallisation, Light Filters, and Standard Absorption Bands.* **W. W. Coblentz.** (Bureau of Standards, Bull. 7. 4. pp. 619–668, Dec., 1911.)—In judging the condition of water in minerals, the main difficulty is to find substances which in the anhydrous state are free from absorption bands liable to be confused with the absorption bands of water at 1·5, 2·3, 4·75, and 6 μ. This is practically impossible, and the best that can be done is to investigate different substances in different regions of the spectrum. A given column of water-vapour is far more transparent than the same column when condensed into a liquid film over the same base. The apparatus used was essentially the same as in the author's previous work. The method is analogous to that of spectro-photometric measurement, with a very sensitive vacuum bolometer substituted for the eye. Under the heading "Minerals containing water of crystallisation" are described the characteristics of several crystalline and amorphous substances containing water. The radiometric test makes no distinction between water of crystallisation, absorbed water, or water in solid solution. The characteristics of water in the liquid and vapour states are discussed. Opals having different amounts of water, from 8 to 8 per cent., were investigated. It was found possible to decrease the water content of, and even to completely dehydrate, some specimens without seriously impairing their homogeneity. After dehydrating a certain sample of opal, it absorbed water at the rate of 0·06 per cent. per day. The transmission curves are so widely separated that an increase in water-content of 0·02 per cent., equivalent to a liquid film of 0·00008 mm., could have been detected, the thickness of the opal being 0·105 mm. The water contained in variable proportion in opal shows no trace of crystallisation, and is considered a solid solution. The transmission curve of opal has the general outline of the curve for water. A hydration curve is given showing the variation of water in opal with atmospheric humidity; there is a lag of half a day in the curve. Transmission curves are also given for selenite, anhydrite, and quartz, at different stages of dehydration. The transmission curve of selenite indicates the presence of water in more nearly the vapour state, in which it is possible to resolve the large bands into small ones.

Change in density of water in the process of crystallisation involves energy-changes which may require consideration in connection with the question of thermal equilibrium in dehydration. Under the heading "Minerals containing water of constitution," are discussed minerals which contain water, but which do not show the characteristic absorption bands shown by water in its free liquid state. The transmission curve of muscovite mica after dehydration shows the absorption bands common to silicates, and none common to those of water. The section of tremolite examined was found to contain 2 per cent. of water. From a comparison of the transmission with that of a layer of water of equivalent thickness, it seems evident that the water in tremolite is in an entirely different condition from that obtaining in the crystals and solid solutions previously investigated. From further data it appears that in tremolite the water is constitutional, with OH-groups, the small band at $2{\cdot}95\,\mu$ being complex, as in other hydroxides. This is contrary to the vapour-pressure experiments, but is the most satisfactory conclusion to be drawn from the present experiments. Some miscellaneous substances having no direct bearing on the problem were also examined, including gelatin, olive oil, linseed oil, oleic acid, chitin, sylvite and quartz. In gelatin the appearance of the transmission curve is entirely unlike that of water, the absorption bands are sharp and narrow, as usually found in carbohydrates; the curve appears as though the water were present as water of constitution, the sharp band at $3\,\mu$ being due to OH-groups. Study of oleic acid indicated that a very much larger dispersion than is now employed is necessary to obtain much information from study of complex absorption bands such as are found in fatty acids. Chitin is the horny integument covering fireflies, through slits in which their light is emitted. The dry chitin curves have the characteristic absorption spectrum of complex carbohydrates in which there is great opacity from $2{\cdot}8\,\mu$ to $3{\cdot}8\,\mu$, and beyond $6\,\mu$, with a fairly transparent region at $4{\cdot}5$ to $5\,\mu$. The data show that but little radiant energy of wave-length greater than $2{\cdot}5$ will get out of the insect's body. Light-filters which absorb the infra-red are next discussed. A saturated solution of copper sulphate is completely opaque beyond $0{\cdot}6\,\mu$; the transmission is high in the blue, so that this substance is suitable for eliminating all but blue light. The most suitable screen for absorbing the infra-red, and at the same time having a high transmission in the yellowish-green and the blue, is cupric chloride. The last section of the paper treats of spectral lines suitable for infra-red standards. As a fiducial line, the yellow He line at $0{\cdot}5876\,\mu$, obtained in an ordinary vacuum tube, is convenient. Transmission spectra of solids and liquids are the most easily observed. Sharp bands of emission of oxides are also easily produced. Zirconium oxide, feldspar, and talc give excellent standard lines. An ordinary Bunsen burner furnishes a sharp intense band at $4{\cdot}40\,\mu$. A. E.

1355. *Anomalous Dispersion and Magnetic Rotation in Glowing Hydrogen; Broadening of Spectrum Lines.* **R. Ladenburg.** (Ann. d. Physik, 38. 2. pp. 249–318, May 23, 1912.)—In an oscillatory circuit containing the source of light (a capillary filled with hydrogen under high pressure) and the absorbing medium (hydrogen under variable pressure), the electrical conditions and the pressure were varied, and the breadth of absorption lines, dispersion and magnetic rotation in the neighbourhood of H_α (6563 Å.) and H_β (4861 Å.) observed qualitatively and quantitatively. The author makes a preliminary investigation of the electrical conditions (discharge potential, capacity, inductance, and damping). From the results N, the number of absorbing centres in unit volume is calculated in each case. Voigt's and Drude's theories of magnetic rotation are compared. The breadth of absorption lines in different thicknesses of incandescent sodium vapour is measured and N calculated, and previous work on the same subject considered. The author concludes that (1) The magnetic rotation in glowing hydrogen, like other metallic vapours, follows the laws of Voigt's theory (Hall-effect), not those of Drude's (molecular currents). (2) Negative electrons are apparently the absorbing centres in the gas, from their specific charge and from the sense of the magnetic rotation. (3) The influence of damping on the electron vibrations cannot be proved, either from the magnetic rotation or from the dispersion. (4) Therefore, according to the dispersion theory, with the exception of the specific constants of the electron (charge, period), N is the sole factor which determines these phenomena. The experiments give $\rho\,(=4\pi Ne^2/m)$. ρ as found from magnetic rotation and from dispersion agrees well and is of the same order as for other metallic vapours. (5) ρ increases linearly with regard to current amplitude but less rapidly with regard to pressure. N is calculated from $\rho=4\pi Ne^2/m$, where e is the charge of an ion. N appears much smaller than u (number of molecules) $10^{-6}<N/u<10^{-4}$. (6) The magnetic rotation cannot be detected with certainty near H_β, but the dispersion is measurable. $\rho_\beta/\rho_\alpha=1:4{\cdot}5$ approximately. (7) The broadening of spectrum lines observed in these and most other experiments on hydrogen and lines of metal vapours, especially sodium, in flames and furnaces can be explained qualitatively by the increase of centres of emission and absorption without supposing an alteration in the electron vibration. J. M.

1356. *A Peculiar Appearance in a Bunsen Flame, and the Flame Spectrum of Sulphur.* **E. S. Johansen.** (Zeitschr. wiss. Phot. 11. pp. 20–26, April, 1912.)—The author's attention was called by K. S. Kristensen to the fact that when a cold body, such as a Jena glass flask filled with water, is held in a Bunsen flame, the surface of the body appears covered by a thin sheet of intense bluish-violet flame, of very different tint from the rest of the flame. This sheet is separated from the flame proper by a dark layer 1 to 2 mm. in thickness. Investigation shows the phenomenon to be due to the presence of sulphur in the Bunsen flame. The spectrum of the light is, however, much simpler than the ordinary banded spectrum of sulphur obtained by electric discharge through sulphur vapour; it resembles a spectrum measured by Salet [Comptes Rendus, 73. p. 559, 1871], and consists of bands sharp on the side of shorter wave-length. Measures of the sharp edge of some 40 bands are given. The construction of the spectrum is very regular, so that the series can easily be found. The spectrum consists mainly of one series of double edges, and one series of single edges, both series being satisfactorily represented by a Deslandres formula. Comparison of the measures with the ordinary banded spectrum of sulphur leaves uncertainty of identity. Salet was of opinion that his spectrum was identical with the absorption spectrum of sulphur vapour, and if this could be proved it would settle the question whether the spectrum observed is that of sulphur or of one of its combinations. A. E.

1357. *Variations in Radiations from Quartz Mercury-vapour Lamps.* **A. Tian.** (Comptes Rendus, 155. pp. 141–144, July 8, 1912.)—The author has previously shown that the peroxidation of water is produced by radiations of very short wave-length, and that the light emitted by a quartz mercury lamp at low electric pressure contains a group of rays of wave-length about 1850 Å. It is further known that hydrogen peroxide and ozone are rapidly decomposed by the middle portion of the ultra-violet spectrum. Experiments are now carried out, the results of which lead to the conclusion that the phenomena observed when the lamps are run at high voltage is not due to the diminution in intensity of the rays generating ozone and hydrogen peroxide, but to the enormous increase in intensity of those rays which destroy these substances. The spectra of various regions of the ultra-violet portion of the mercury arc is studied photographically at different electric pressures. At the very low pressure of 23–25 volts with a 150-volt lamp the existence of a single fine ray in the extreme ultra-violet (1849 Å.) is established. When the pressure is increased to 30 volts the ray increases in width and an absorption line appears in its centre. This absorption line increases rapidly in thickness as the p.d. is still further increased. It is very probable that the inversion of ray 1849, like that of some others in the mercury arc, is due to the non-luminous vapour which under certain conditions surrounds the very brilliant central line of the arc. A. E. G.

1358. *Sodium D-lines.* **H. V. Brotherus.** (Ann. d. Physik, 38. 2. pp. 397–433, May 23, 1912. From Dissertation, Helsingfors.)—An elaborate experimental and theoretical investigation of the intensity distribution in the sodium D-lines. Good agreement is obtained between the experimental results and theory. The paper does not admit of a brief abstract. A. W.

1359. *Absorption Spectra and the Solvate Theory of Solutions.* **H. C. Jones.** (Phil. Mag. 23. pp. 730–742, May, 1912.)—A very convenient summary is given of the voluminous American publications on the absorption spectra of salts. The most important result arrived at is that in the case of a number of salts, especially neodymium chloride and uranyl chloride, an entirely different set of absorption-bands appears when the solvent used is changed from water to alcohol or acetone, whilst in mixtures of two solvents both sets of bands appear. The transition from one set of bands to the other on changing from one pure solvent through a series of mixtures to another pure solvent is thus effected by a gradual diminution in the intensity of one set of bands and a gradual strengthening of the other set, and not by a gradual shifting of the positions of the bands. In these cases it appears to be proved clearly that the bands in question are due to compounds of the solvent with the solute. In other cases, *e.g.*, the ultra-violet absorption of cobalt salts, the intensity of the band is proportional to the number of non-ionised molecules of the salt which appear to be the cause of the absorption, whilst the absorption bands of cobalt in the green, of nickel and of copper in the red end of the spectrum are proportional to the number of atoms of metal in the solution and may be regarded as atomic properties. T. M. L.

1360. *Intensity Relations in the Spectra of Hydrogen, Oxygen, and Carbon Dioxide.* **J. Schwedes.** (Zeitschr. wiss. Phot. 11. pp. 169–204, June, 1912.)—The author has observed the intensities of the lines compared with a Nernst lamp, using as the source of light, in each case, a stream of gas electrically excited by a direct current. The investigation gives the following results :—(1) *Hydrogen.*—In the first secondary series the intensity of the lines increases more rapidly than the current. The energy maximum moves towards the shorter wave-lengths as in the case of a black body with rising temperature. In the second hydrogen spectrum the intensity of the lines increases less rapidly than the current. (2) *Oxygen.*—Both in the first and in the second secondary triplet series the intensity increases more rapidly than the current (temperature); but no displacement of the energy maximum can be detected at low pressures (1·7 mm.). At higher pressures (5·3 mm.) a displacement towards the larger wave-lengths is observable. (3) *Carbon Dioxide.*—The intensity of the bands increases linearly with regard to the current. This holds not only for the edges but also for other points within the bands. J. M.

1361. *Mass of Particles which emit the two Hydrogen Spectra.* **C. Fabry** and **H. Buisson.** (Comptes Rendus, 154. pp. 1500–1502, June 3, 1912.)—Using the method previously employed by them [Abstract No. 1190 (1912)], the authors have investigated the limits of interference in the case of the two hydrogen spectra, and from these results have deduced the mass of the particles which emit these lines; they find the mass is practically the same as the atomic mass of hydrogen. The number of the limiting order of interference for the lines of the second spectrum is 72,000 when the vacuum tube is kept in a water-bath at the room temperature. From this result they conclude that the emitting particles are identical with the H-atoms or differ from them very little. The Balmer series (first spectrum) is more difficult to work with, as the lines are double, and experiments showed that there exists for them another cause of increased width of the lines besides the molecular agitation, possibly related to the current density in the tube. The first line of the series H_α 6563 at ordinary temperatures has two components so wide as almost to touch; when at liquid-air temperature the two lines are well separated. The two components are not of equal intensity, the component of greater wave-length being the more intense; the distance between the two components is 0·132 Å. The red line H_α gives for the limits of interference, 50,000 with the tube at ordinary temperature, and 68,000 with the tube in liquid air. These numbers are a little less than those corresponding to the atomic mass, but this is not surprising in view of the difficulty of observing interference with a double line. It thus seems probable that the lines of both spectra of hydrogen are emitted by particles having the mass of the hydrogen atom. A. W.

1362. *Arc Spectrum between Carbon Electrodes at Low Pressures.* **La Rosa.** (Accad. Lincei, Atti, 21. pp. 640–646, May 19, 1912.)—Examination of the arc spectrum between carbon electrodes as the pressure is reduced, shows that down to a pressure of a few cm. of mercury there is no appreciable change either from the electrical or optical point of view, except a reduction in intensity of the cyanogen band, and an increased intensity in the lines of the metallic impurities in the flame around the negative carbon. When the pressure is further reduced to a few mm. of Hg the form of the arc alters, assuming that characteristic of the discharge at low pressures, but there is no change in the electrical conditions. The distribution of intensity along the spectrum is very different in this case, the cyanogen band being again much weaker, but the most notable feature is the presence of the band usually attributed to C + H, associated with the lines H_α, H_β, H_γ of the primary spectrum of hydrogen. It is concluded that there are several phases of the electric arc, which, though not distinguishable by electrical means, can be clearly differentiated with the spectrometer. W. H. Si.

1363. *Emission and Absorption Power of a Non-homogeneous Source of Light.* **H. V. Brotherus.** (Phys. Zeitschr. 13. pp. 540–544, June 15, 1912.)—Ladenburg's researches on the emission and absorption power of luminescent hydrogen show that Kirchhoff's law of proportionality between emission and absorption power of a spectrum line is not obeyed [Abstract No. 1458 (1910)]. In the present paper Ladenburg's results are discussed, and the conclusion is reached that for non-homogeneous sources of light such as Ladenburg used, Kirchhoff's law is not valid; but, as Voigt showed theoretically [Abstract No. 767 (1911)] the law probably holds for homogeneous sources. Experiments are also described with sodium light, and again it appears that for spreading non-homogeneous sources the law does not hold. A. W.

1364. *Critical Study of Spectral Series.* II. **W. M. Hicks.** (Roy. Soc., Phil. Trans. 212. pp. 33–73, June 17, 1912.)—A continuation of previous work [Abstract No. 898 (1911)]. In the present paper the constitutions of the sequences on which the principal and sharp series (p and s sequences) depend, and their relation to the atomic volume of the element, which were brought to light in Part I., are further considered in connection with the spectra of the second and third groups of elements. The type of formula used has previously been employed by Mogendorff, who showed that it reproduces the lines of Li, Na, Zn, and Tl in the different series with great exactness. The most important result of the discussion appears to be the considerable weight of evidence that the series lines—at least the principal and sharp ones—depend in a very definite way on what is generally understood as the atomic volume of each element. The numerical evidence afforded from a study of the low-melting-point elements of the first three groups of the periodic system is remarkably exact. The numerous lines of all these series are represented within limits of error, and as a rule with extreme closeness, by the formula adopted:—

$$n = \mathrm{A} - \mathrm{N}/[1 - \mathrm{W}(1 - m^{-1}) + \mu + am^{-1}]^2.$$

The high-melting-point elements of group II. do not show the law with such certainty, but there are clear indications of it. In these elements the type of formula has required a modification, and, in addition, the series are not well developed in the higher members Sr, Ba, and Ra. Consequently the limits are not determined with such certainty as in the other cases. Nevertheless Mg and Ca quite fall into line with the others, and even in Ra it is possible to give some indications of the value of the density of the solid metal. The fact that the terms depend on multiples of atomic volumes as ordinarily calculated may be interpreted in one of two ways: either that the periods of the vibrating configurations do actually depend on multiples of the essential atomic volumes, or that multiples do not enter here, but that the packing together of the configurations when they are aggregated into solid masses is closer or less close. On the first view the multiples depend on the internal configuration of the atom, on the second on the configurations of the molecules in gross matter, or, in other words, on the value of the ratio atomic weight to density. If the first interpretation is correct we might expect to find other series in an element depending on other multiples. The author is not sure he has not observed indications of such, but further research will be necessary before a definite statement can be made. On the second interpretation no such additional lines can be expected. Additional evidence to that obtained in Part I. is adduced of the existence of a universal constant, approximately 0·21520, which gives the ratio of a/μ in the p-sequence $\mu + a/m$, and also in the s-sequence if certain relations indicated between the s- and p-sequences are found to be exact. This constant must be a pure number, in contradistinction to N, which is of the dimension (length)$^{-1}$. A comparison of the denominators of the series $VP_1(m)$, $VP_2(m)$, $VP_3(m)$ shows that whilst in the alkalies they differ by the same amount in the same element for all orders, in the second and third groups the difference proceeds in two steps, viz., that after the first order the remaining differ by the same amount, and this is about 7 times the difference for $m = 1$. Further, a comparison of the above with $VS(m)$ shows that a similar law holds between the denominators of $VS(m)$ and $VP(m)$. These laws are applied as a criterion to the lines allotted by Paschen for HgP, MgP and CaP, and, in consequence, certain modifications are suggested. It is found in the second and third groups, in opposition to the first, that the S series follows the p-sequence and the P series the s-sequence. An attempt is made to arrange the S and D series for Eu and Ra. Eu is found to fit the gap between Cd and Hg and a density 12·58 deduced for it. The density of Ra should be $1{\cdot}02x$, where x is probably 5 or 6. Further work on these lines will be published later. A. W.

1365. *Width of the Intensity Minimum in the Doppler-effect with Canal Rays.* **J. Stark.** (Ann. d. Physik, 38. 2. pp. 459–466, May 23, 1912.)—Stark has previously stated the view that the width of the intensity minimum increases with diminishing wave-length, while Paschen [Abstract No. 1348 (1907)] contends that there is no connection between these quantities. Stark now shows that the measurements obtained by himself and Steubing, as well as those of Royds are in favour of his hypothesis and contrary to those of Paschen. A. E. G.

1366. *Zeeman-effect.* **O. Lüttig** [with **W. Hartmann, C. Peterke**]. (Ann. d. Physik, 38. 1. pp. 43–70, May 7, 1912.)—An investigation of the structure and magnetic resolution of lines in the visible spectra of Cu, Fe, Au, Cr, Ni, Pd, Mn, and argon, by means of an echelon grating ($\lambda/d\lambda$ for Fraunhofer lines A and H between 256,000 and 585,000). Most of the lines split up into triplets and quartets. All the lines show normal polarisation. Series cannot be detected with any certainty. The effect is proportional with the strength of field in all cases. J. M.

1367. *Zeeman-effect in Hydrogen and Nitrogen.* **F. Croze.** (Comptes Rendus, 154. pp. 1410–1411, May 28, 1912.)—A large Weiss electromagnet was used in conjunction with a 3·10 m. radius Rowland grating. The tube of gas under investigation was placed so that the discharge was not modified by the magnetic field. By means of a system of lenses and a rhombohedron of spar, a double image of the portion of the tube between the pole-pieces was projected on the collimator slit, so that on the photographic plate were obtained two superposed spectra, one corresponding to vibrations parallel to the field, the other to those perpendicular to the field. The third-order spectrum given by the grating was particularly luminous, so this was used throughout. The measurements of the field were made by comparison with the measurements of Cotton and Weiss on the blue lines of zinc. For each of the three principal lines of hydrogen the vibrations parallel to the field give a single component coincident with the primitive line, though the vibrations perpendicular to the field give a symmetrical doublet. Measurements of the value of $\Delta\lambda/H\lambda^2$ for the lines H_α, H_β, H_γ gave the results $0·95 \times 10^{-4}$, $0·96 \times 10^{-4}$, $0·98 \times 10^{-4}$ respectively. Examination of these results shows that the H series, which is a first subordinate series, gives for each of these lines a pure triplet of the normal type. This fact, though not ordinarily met with in the first subordinate series of metals, is found in the He lines studied by Lohmann, of which many belong to the first subordinate series. So the rule of Preston and Runge receives a new verification and the connection between hydrogen and helium established chemically is confirmed. Cotton has shown that, even with lines not yet put into series, the value $\Delta\lambda/H\lambda^2 = 1·41 \times 10^{-4}$, which corresponds to 1½ times the normal separation, is a special value. The author, using a field of 24,090 gauss, has found this value for a characteristic group of blue lines in the spectrum of nitrogen. They give a single component for the vibrations parallel to the field and a symmetrical doublet for the vibrations perpendicular to the field. Measurements of the separation $\Delta\lambda$ of these doublets give the following results :—

λ.	$\Delta\lambda$.	$\Delta\lambda/H\lambda^2$.
4601·54	0·75	$1·46 \times 10^{-4}$
4607·16	0·72	1·41 ,,
4613·88	0·71	1·39 ,,
4621·46	0·72	1·41 ,,
4630·58	0·72	1·40 ,,
4643·85	0·73	1·40 ,,
4803·53	0·68	1·12 ,,

The error in the last measurement is probably due to the feeble intensity of the components. A. W.

1368. *Distribution of Scattered Röntgen Radiation.* **J. A. Crowther.** (Roy. Soc., Proc. Ser. A. 86. pp. 478–494, May 8, 1912.)—The paper contains an account of certain experiments relating to the discussion given in Abstract No. 1196 (1912). It is shown that the secondary Röntgen radiation round a radiator, in the absence of any homogeneous secondary radiation, is divisible into two parts : (1) the scattered radiation distributed in accordance with the usual theory ; (2) an excess radiation of the same quality. An expression is deduced for the distribution of the excess radiation, and the constants of the expression are determined for different radiators and different qualities of the primary rays. The excess radiation may possibly be explained as due to a deflection suffered by a small fraction of the primary Röntgen pulses in encounters of a special type with the atoms of the radiator. Of the nature of such collisions there is at present no information. On the other hand, the similarity of the distribution curves of the excess radiation to those for a parallel beam of β-rays suggests that possibly the kathode particles which are given off in quantity when Röntgen rays fall upon a radiator, may play some part in its production. From this point of view, the excess radiation would be due to the re-transformation into X-rays of some fraction of this secondary kathodic radiation. Further assumptions appear, however, to be necessary, and experiments are in progress to test these points. E. M.

1369. *Absorption of Soft Röntgen Rays.* **W. Seitz.** (Phys. Zeitschr. 13. pp. 476–480, June 1, 1912.)—The work of Barkla and others has shown that certain similarities exist between X-rays and light. Thus the secondary X-rays excited in different materials are characteristic of the elements emitting them and are of the nature of fluorescent radiations. However, in the case of compounds the absorption for X-rays appears to depend only on the constituent elements, whereas this does not hold for light-waves. Similarities between light and X-rays should be more pronounced the softer the latter are, *i.e.* the greater the thickness of the pulse. To test this point the author has determined the absorption of very soft X-rays by various gases. X-rays corresponding to potential differences of 900 to 1400 volts were used and the ionisation effects increased by ionisation by collision. The results show that the absorption of a compound gas for these soft rays is simply the additive absorption of the elements constituting it, *i.e.* the same law holds for very soft X-rays as for hard rays. In general the relative absorption of different gases was found to obey a less simple law for soft X-rays than for hard rays. E. M.

1370. *Ranges of α-Particles of Successive Radio-active Products.* **F. Butavaud.** (Le Radium, 9. pp. 203–205, May, 1912.)—The author assumes that an atom consists of successive rings of electrons. Taking N as the number of electrons in the outer ring, he assumes that N is decreased by six on the emission of an α-particle and decreased by one on the emission of a β-particle. It is shown that for most α-ray products of the same radio-active family the product $N \times P_i$ is constant, where P_i is the range of max. ionisation of the α-particle or about 6 mm. less than the ordinary range. E. M.

1371. *Passage of β-Rays through Matter.* **J. Danysz.** (Comptes Rendus, 154. pp. 1502–1504, June 3, 1912.)—By means of the radiographic method previously described [see Abstracts Nos. 1349 (1911) and 825 (1912)] the author has studied the retardation which β-rays undergo on passing through various substances. The results show that, to a first approximation, a screen of given thickness produces on the β-particles a retardation proportional to its density. Making use of J. J. Thomson's theory of the retardation of β-particles by matter to deduce the number of electrons in an atom, the results lead to numbers of the same order of magnitude as the atomic weights. A. W.

1372. *The Radiation penetrating within a Closed Vessel during the Eclipse of April* 17, 1912. **de Broglie.** (Comptes Rendus, 154. pp. 1654–1655, June 10, 1912.)—The conductivity of air inside a closed vessel is ascribed to a radiation penetrating the walls of the vessel from without. Measurements at Paris on April 17 of the rate of production of ions in a sheet-iron vessel gave a value of 12 ions per cm.^{3} per sec. No appreciable variation from this rate took place during the time of eclipse. R. C.

1373. *β-Rays from the Active Deposit of Thorium.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 13. pp. 390–393, May 1, 1912.)—The experiments show that the β-rays from ThD obtained by recoil from thorium active deposit are more easily absorbed than those from (C + D) [nomenclature of Rutherford and Geiger, Abstract 160 (1912)]. The result thus suggests that ThC gives rise to a penetrating β-radiation. If a Ni plate is dipped for a short time in a solution of thorium active deposit, the activity as measured by β-rays is shown to rise from an initial value of about 70 per cent. of the maximum before decaying with a period of 60 minutes (ThC). The γ-ray activity of such a plate, however, rises from about 5 per cent. of the max. activity. These experiments show that practically pure ThC is deposited on the Ni plate, the subsequent rise in activity being due to the growth of ThD. Further, the experiments show that practically all the γ-rays come from ThD. It is calculated that the β-radiation from ThC is reduced to half value by 0·48 mm. of Al, and that from ThD by 0·32 mm. of Al. E. M.

1374. *Optical Constants of Metals from Polarisation Measurements.* **D. A. Goldhammer.** (Phys. Zeitschr. 13. pp. 537–539, June 15, 1912.)—Laue and Martens [Abstract No. 286 (1908)], and v. Uljanin [Abstract No. 88 (1911)] have obtained the optical constants of metals from polarisation measurements, but the formulæ used by them were so complicated that calculation of the results was very laborious. The present paper gives formulæ which render the calculations much easier. A. W.

1375. *Magnetic Analysis of Liquid Crystals.* **O. Lehmann.** (Phys. Zeitschr. 13. pp. 550–559, June 15, 1912.)—Twenty-five photographs are given showing the influence of a magnetic field in the case of (1) small crystal-drops in a longitudinal magnetic field ; (2) small drops in a transverse field ; (3) large crystal-drops, lines of force across the direction of vision. T. M. L.

1376. *Spectroscopy and Atomic Theory.* **C. Runge.** (Zeitschr. Elektrochem. 18. pp. 485–490 ; Discussion, pp. 490–492, July 1, 1912. Paper read before the Deutsch. Bunsen-Gesell., Heidelburg, May, 1912.)—A popular summary of the present state of knowledge of series in spectra. The discussion covered the whole range of spectroscopy dealt with at the meeting. E. E. F.

1377. *Emission of Spectrum Lines.* **J. Stark.** (Phys. Zeitschr. 13. pp. 532–535, June 15, 1912.)—A discussion of the kinetic energy necessary for the emission of spectrum lines, with reference to the theories previously advanced by the author and by Planck [see Abstracts Nos. 406 (1908), 1178 (1911)]. A. W.

1378. *Barium Spectrum.* **K. Schmitz.** (Zeitschr. wiss. Phot. 11. pp. 209–235, July, 1912.)—Gives first a *résumé* of standard wave-length determinations, then measurements of the wave-lengths of the arc and spark lines of Ba obtained with a large Rowland concave grating. The table of wave-lengths, in international units, gives for comparison the results of Kayser and Runge, Hoeller, Eder and Valenta, and Exner and Haschek. The latter part consists of a general discussion on various formulæ for spectrum series. A. W.

1379. *Antimony Spectrum.* **H. Schippers.** (Zeitschr. wiss. Phot. 11. pp. 235–240, July, and pp. 241–253, Aug., 1912.)—Gives the results of measurement, based on the international normal, of the arc and spark lines of Sb. The results of Kretzer, Eder and Valenta, Exner and Haschek, and Kayser and Runge, are given for comparison. A large Rowland concave grating was used. [See also Abstracts Nos. 1730 (1910) and 1365 (1911).] A. W.

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1380. *A Metallographic Hygroscope.* **C. Benedicks** and **R. Arpi.** (Inst. of Metals, Journ. 7. pp. 246–248, 1912. Engineering, 93. p. 135, Jan. 26, 1912.)—When a polished plate of zinc-antimony alloy is held over a vessel containing aqueous hydrochloric acid, the surface is not etched, but minute drops of acid settle on the alloy, each drop leaving a thin layer displaying bright interference colours. These colours are not constant, but change with temperature. Similar films, apparently of zinc chloride, are also obtained with alcoholic hydrochloric acid. The alloy should not contain more than 27 per cent. of Zn. In special experiments a thermo-couple was inserted into a metallographic specimen which was cooled; the number of interference rings on the sensitive spot increased from 1 to 7 as the temperature fell from 17·5 to 8·5° C. The curve connecting temperature and film thickness is regular, and the thickness increases with falling temperature the more, the nearer the temperature is to the dew-point; the dew-point might be determined in this way. H.B.

1381. *The Expansion of Silica and Mercury.* **H. Donaldson.** (Phys. Soc., Proc. 24. pp. 186–194; Discussion, pp. 199–200, June 15, 1912.)—In the National Physical Laboratory are standards of invar, nickel, and 43 per cent. nickel steel whose expansions have been determined at the *Bureau International.* Against these was measured the expansion of a silica rod, 1 m. long, and a parabolic formula for the linear expansion of silica is deduced which agrees well with results obtained for silica by Fizeau's interference method. But Harlow's weight-thermometer experiments give very different values for silica when Callendar and Moss's coefficient for mercury is used. So either it is inadmissible to assume isotropy of the silica tube used in Harlow's experiments or the coefficient for mercury given by Callendar and Moss is in error. The latter is smaller, for the range 0° to 100°, by 0·3 per cent. than that found by Chappuis, and if this smaller value for the coefficient of mercury is correct then it would seem that the *verre dur* and iridio-platinum tubes used by Chappuis are also anisotropic. [See next Abstract.] P. E. S.

1382. *Expansion of Vitreous Silica.* **H. L. Callendar.** (Phys. Soc., Proc. 24. pp. 195–199; Discussion, pp. 199–200, June, 1912. Phil. Mag. 23. pp. 998–1000, June, 1912.)—An account is given of investigation made on the expansion of silica in 1901 and which was briefly published by the Physical Society in that year. Since the discussion raised recently on the coefficient of expansion found by Callendar and Moss, fresh experiments have been made. These have confirmed the accuracy of the work of Callendar and Moss on the expansion of mercury for low temperatures, and indicate that the values generally assumed for the expansion of mercury and water are appreciably too high. There is direct experimental proof of the anisotropy of drawn silica tube, so that any assumptions based on isotropy of this material would therefore fall. [See also Abstract No. 1225 (1912).] P. E. S.

1383. *Expansion Coefficient of Graphite.* **A. L. Day** and **R. B. Sosman.** (Washington Acad. Sci., Journ. 2. pp. 284–289, June 19, 1912.)—The expansion coefficient of Acheson artificial graphite was measured over the range of temperature from 0° to 1500°. The expansion was measured with a comparator directly on a bar 70 × 0·5 × 0·3 cm. The bar was heated by sending a heavy current through it, and the temperature was found by noting the melting-point of small fragments of Al (658°), Ag (960°), Cu (1083°), and the mineral diopside (1391°) lying upon the bar, intermediate temperatures being read by means of an optical pyrometer. The coefficient of expansion was found to be very small, though increasing rapidly with rising temperature. The total expansion up to 1000° is only about one-fifth of that of Pt. The results may be expressed by the formula $10^6\beta = 0{\cdot}55 + 0{\cdot}0016t$ in which β is the mean linear coefficient $\Delta l/l_0 t$ from 0°. The "true coefficient" α or rate of expansion $(1/l_0 \,.\, dl/dt)$ at any temperature t is thus: $10^6\alpha = 0{\cdot}55 + 0{\cdot}032t$. If this equation holds below 0° the true coefficient would become zero at about −170° or this would be the temperature of max. density. J. J. S.

1384. *Expansion of Saturated Water-vapour.* **A. Leduc.** (Comptes Rendus, 155. pp. 33–35, July 1, 1912.)—The author deduces from the results of Holborn and Henning, and of Dieterici, the values of n between 160° and 80° C. in Rankin's formula $pv^n = \text{constant}$. The values obtained agree closely with those calculated from Regnault's figures, and range from 1·136 at 100–80° to 1·144 at 140–120°, falling again to 1·143 for 160–140°. W. H. Si.

1385. *Specific Heat of Water according to Regnault's Experiments.* **C. E. Guillaume.** (Comptes Rendus, 154. pp. 1483–1487, June 3, 1912.)—Recent determinations of the specific heat of water are in good accord up to about 60° and show a minimum which was not detected by Regnault. In order to use to the best advantage the determinations of Regnault between 60° and 200°, the author has assumed a value for 60° and calculated values for higher temperatures from Regnault's differences. The following table shows (1) the values thus deduced from Regnault's measurements; (2) those calculated from the formula—

$$C = 0{\cdot}9994 + 0{\cdot}0002620\,(\theta - 60) + 0{\cdot}0000001608\,(\theta - 60)^2,$$

which agrees at 60° with the general average 0·9994; (3) those calculated from the formula

$$C = 1{\cdot}0008 + 0{\cdot}0001666\,(\theta - 60) + 0{\cdot}0000010074\,(\theta - 60)^2,$$

which agrees at 60° with Dieterici's value but is calculated to fit Regnault's observations; (4) Dieterici's values.

	Regnault.	Calc (1).	Calc (2).	Dieterici.
60°	1·0048	0·9994	1·0008	1·0008
80	1·0081	1·0047	1·0045	1·0043
100	1·0122	1·0101	1·0091	1·0097
120	1·0169	1·0157	1·0144	1·0162
140	1·0224	1·0214	1·0206	1·0248
160	1·0286	1·0272	1·0275	1·0352
180	1·0356	1·0332	1·0353	1·0472
200	1·0432	1·0392	1·0439	1·0608

The second series of calculated values is preferred. T. M. L.

1386. *Convection and Conduction of Heat in Gases.* **I. Langmuir.** (Phys. Rev. 34. pp. 401–422, June, 1912.)—In continuation of the work dealt with in Abstract No. 837 (1912). The subject-matter has been dealt with from the author's paper read before the American Institute of Electrical Engineers [see Abstract No. 827B (1912)].

1387. *Constancy of the Sulphur Boiling-point.* **C. W. Waidner** and **C. K. Burgess.** (Bureau of Standards, Bull. 7. No. 1. pp. 127–130, Feb., 1911. Chem. News, 104. pp. 274–275, Dec. 8, 1911.)—The authors have reinvestigated the boiling-point of sulphur, using a resistance thermometer of only 9 mm. length. They find that the temperature of the boiling-point is constant to within 0·05° and probably even 0·03° C., and the temperature is also reproducible within these limits of accuracy with care. A. F

1388. *The Standard Scale of Temperatures between* 200° *and* 1100°. **L. H Adams** and **J. Johnston.** (Washington Acad. Sci., Journ. 2. pp. 275–284, June 19, 1912. Amer. Journ. Sci. 33. pp. 534–545, June, 1912.)—In this note a new calibration curve for copper-constantan thermo-elements, extending from 0° to 360° is given, together with a series of independent measurements of the temperature-differences between the boiling-points of naphthalene (217·95°) and benzophenone (305·9°) on the one hand and the freezing-points of Sn, Bi, Cd, and Pb on the other. These measurements give the following values of the freezing-points: Sn, 231·8°; Bi, 271·0°; Cd, 320·9°; Pb, 327·3°. The concordance of these values with those obtained by other measurements shows that the thermo-element is not inferior to the resistance thermometer within this range of temperature (0 to 360°). Moreover, a comparison of the results obtained with these interpolation instruments (thermo-element, &c.) which measure not temperature indifferently but a well-defined physical property which changes continuously with the temperature, gives an excellent means, *through this continuity*, for the discovery of inconsistences in the gas-thermometer measurements. The remarkable concordance of the authors' thermoelectric measurements and the most extensive recent series of resistance thermometer measurements—those of Waidner and Burgess made at the Bureau of Standards—on the one hand, with the recent gas-thermometer determinations of Day and Sosman on the other, serves therefore as an efficient and independent check upon the trustworthiness of the present gas-thermometer scale between 0° and 1100°. J. J. S.

1389. *Chemical Gas Constants and the Elementary Action Quantum.* **H. Tetrode.** (Ann. d. Physik, 38. 2. pp. 434–442, May 23, 1912.)—According to Boltzmann, the entropy S of a system is linked with its "probability of condition" W by the equation $S = k \log_e W + \text{const.}$, where k, according to Planck, has the value $1{\cdot}346 \times 10^{-16}$ erg/deg. Nernst's "chemical constant" a of a gas is defined by the equation $S = C_p' \log_e T - R \log_e p + a + C_p'$, where C_p' is the molar specific heat at constant pressure. The author shows that a is given for any monatomic gas by the relation $A = \alpha + (3/2) R \log_e M$, where M is the molecular weight and α a universal constant. The chemical constant may be determined for any gas by measurements of its specific heat, preferably at very low temperatures. E. E. F.

1390. *Internal Pressure of Fluids.* **E. H. Amagat.** (Comptes Rendus, 154. pp. 909–914, April 9, 1912.)—In calculating the internal pressure of fluids it is necessary to take into account certain small variations of the pressure coefficient with the temperature. These variations are necessitated by the variations of the specific heat at constant volume with this volume, as shown by J. Joly in the case of air and CO_2. The variations in the coefficient may be calculated approximately by supposing, for instance, that the differences in the coefficient vary inversely as the temperature-differences. From this it results that the order of magnitude of the variations of the pressure coefficient with the temperature, which correspond to those of the specific heat with the volume, is such that these latter variations (if small), could not be deduced with certainty from even the best pressure determinations available, such as Kamerlingh Onnes' measurements on argon, hydrogen, and helium. There is probably some systematic error in the determination of pressures, possibly due to the condensing action of the walls. E. E. F.

1391. *Standardisation of Bomb Calorimeters.* (Bureau of Standards, Circular No. 11 (10 pp.), Washington, 1911.)

1392. *Calibration of Radiation Pyrometers.* **G. A. Shook.** (Metallurgical and Chem. Engin. 10. pp. 416–420, July, 1912.)—Gives practical hints and examples on the calibration of total radiation pyrometers, optical pyrometers, and of the Wanner, le Chatelier and Holborn-Kurlbaum pyrometers. L. H. W.

1393. *Relation between Coefficients of Expansion of Liquids and their Critical Temperatures.* **H. Davies.** (Phil. Mag. 23. pp. 657–659, April, 1912.)

1394. *Equation of State in the Region of Small Volumes.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 527–562, 1911. Ann. d. Physik, 37. 5. pp. 975–1013, April 16, 1912.)—Unsuitable for abstracting.

1395. *Deduction of Thermo-dynamical Relations.* **J. P. Kuenen.** (Phil. Mag. 23. pp. 752–757, May, 1912.)—This paper is mainly a criticism of the treatment pursued in Houstoun's recent papers [Abstracts Nos. 1347 (1910) and 644 (1912).

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1396. *Cohesion of an Electron.* **H. T. Wolff.** (Ann. d. Physik, 36. 5. pp. 1066–1070, Dec. 21, 1911.)—An electron of finite size is only thinkable if we assume the existence of forces which balance the repulsion of similar electric charges. Since the assumption of such forces would bar a purely electromagnetic theory of the electron it might be desirable to make those mechanical forces superfluous by a suitable modification of the fundamental laws [see Abstracts Nos. 1488 (1908), 1427 (1909)]. We might alter the law according to which the field is calculated from the force experienced by a known electric quantity, or that governing the force exerted by a given field. The author tries the latter alternative, and puts the force into the general form $d\epsilon[E + F(E_x, E_y, E_z)]$. This is converted into the expression $(dv/4\pi)[E \operatorname{div} E + K\nabla \operatorname{div} E]$ where $(dv/4\pi)K\nabla \operatorname{div} E$ is analogous to the force in a fluid due to a gradient of density. $K/\operatorname{div} E = k$ is a scalar and is shown to be equal to R^2/π^2, where R is the radius of the electron. Assuming the correctness of the relativity principle, the electron will show the same charge in any state of uniform motion, like the Lorentz electron. E. E. F.

1397. *Electron Theory of Matter.* **O. W. Richardson.** (Phil. Mag. 23. pp. 594–627, April, 1912.)—A continuation of previous work [Abstract No. 925 (1912)]. The law of force governing the collisions of electrons in metals is investigated, and it is shown to be most probably an inverse-cube law. The centres of force are probably sub-atomic structures. The author gives a thermodynamic calculation of the electronic pressure outside a metal which brings the electronic emission into relation with thermoelectric phenomena. There is not necessarily any simple relation between thermoelectric effects and the free electrons which determine the electrical conductivity. The *rôle* of "polarisation" electrons in electrical conduction is discussed largely from the point of view of the way in which galvanomagnetic phenomena may possibly be affected thereby. It is shown that if the mean free path is small compared with the scale of polarisation, a change of sign in the Hall-effect may be accounted for. The application of thermodynamics and statistical principles to ether radiation and photoelectric effects brings out the close similarity between thermionic emission and the photoelectric emission arising from the complete ethereal radiation. E. E. F.

1398. *Electron Theory of Thermo-electricity.* **N. Bohr.** (Phil. Mag. 23. pp. 984–986, June, 1912.)—Gives reasons for the disagreement between his results with regard to the Peltier- and Thomson-effects and those obtained by Richardson [Abstract No. 925 (1912) and preceding Abstract]. The expansion for the Peltier-effect depends not only on the difference in potential energy of the free electrons in the two metals, but also on the difference in kinetic energy transferred by the electric current in the two metals. If this is taken into account, the calculated values for the thermoelectric constants satisfy the conditions given by Kelvin, though this result cannot be rigorously deduced from thermodynamic principles. E. E. F.

1399. *Radiation Hypothesis.* **D. A. Goldhammer.** (Phys. Zeitschr. 13. pp. 585–587, June 15, 1912.)—Consider a sphere of radius R, subjected to the action of a uniform electric field F along the x-axis. If ϕ is the angle between the radius vector (r) and the x-axis, the density of the charge induced on the sphere is given by $\sigma' = \sigma_0' \cos \phi$; $\sigma_0' = 3\mathrm{F}/4\pi$; and the potential of this charge is $\mathrm{V} = \mathrm{FR}^3 \cos \phi / r^2$. If now the field F is suddenly removed, electric oscillations are set up in the sphere, the wave-length being given by $\lambda = 4\pi \mathrm{R}/\sqrt{3}$, so that the oscillation frequency $\mathrm{N} = \sqrt{3}c/4\pi\mathrm{R}$, c being the velocity of light *in vacuo*. At the instant when the oscillations commence the energy of the sphere is $\mathrm{E} = 4\mathrm{Q}^2/3\mathrm{R}$, where Q is the charge on half the sphere and is equal to $\pi \mathrm{R}^2 \sigma_0$, and $\sigma_0 = \mathrm{F}/2\pi$. Hence we get $\mathrm{E} = [16\pi/3\sqrt{3}]\mathrm{NQ}^2/c$. The energy of the sphere is therefore proportional to the oscillation frequency N, exactly as should be the case for Planck's resonators [see Abstracts Nos. 1284 (1901) and 1178 (1911)]. Taking e, the charge on an electron as $4{\cdot}65 \times 10^{-10}$, Q must be equal to pe, where p is an integer. If, however, a certain number n of the electrons are bound with neutral atoms or molecules, the charge Q becomes $q = (p - n)e$. Hence the variation of the energy of the sphere due to radiation is $\Delta \mathrm{E} = [16\pi/3\sqrt{3}](2p - n)ne^2\mathrm{N}/c$, or, neglecting n in comparison with $2p$, $\Delta \mathrm{E} = [32\pi/3\sqrt{3}]pne^2\mathrm{N}/c$. So the small variations of energy of the sphere due to radiation can only be multiples of the quantum $\Delta \mathrm{E} = h'\mathrm{N}$, which again is the property of the resonators in Planck's theory. It is to be expected that similar results would be obtained with conductors of other shapes. If this is the case, in general we should have $h' = fpe^2/c$, where f is a factor varying from one body to another. It is probable that for Planck's resonators $h = 900e^2/c$. A. W.

1400. *Atmospheric Electricity during the Eclipse of April* 17, 1912. **A. B. Chauveau.** (Comptes Rendus, 154. pp. 1652–1654, June 10, 1912.)—The photographic curves for potential gradient furnish no decided evidence of any change in the electric field due to the eclipse. A change in the character of the curves, which occurred on the morning of the 17th, is ascribed to a change of wind direction, since it persisted on the 18th and 19th. Observations of electrical dissipation, by means of an Elster and Geitel apparatus, at the Meudon Observatory, indicate an increase in the rate of loss of negative charge, and a simultaneous decrease in the rate of loss of positive charge at the period of maximum eclipse. R. C.

1401. *Electromagnetic Field in a Uniaxial Anisotropic Medium.* **M. Francesco.** (N. Cimento, 3. Ser. 6. pp. 407–448, June, 1912.)—Mathematical consideration.

1402. *Forces between Point Charges in Space filled by Diffuse Electromagnetic Radiation.* **E. Madelung.** (Phys. Zeitschr. 13. pp. 489–495, June 1, 1912.)—A mathematical treatment obtaining ponderomotive forces in the form of fractions whose numerators are sine and cosine terms and denominators the squares and other powers of the distance. The result may be approximately represented by fluctuations within limits according to the law of the inverse square of the distance. E. H. B.

DISCHARGE AND OSCILLATIONS.

1403. *Diffusion and Mobility of Ions in a Magnetic Field.* **J. S. Townsend.** (Roy. Soc., Proc. Ser. A. 86. pp. 571–577, June 27, 1912.)—A mathematical paper in which the following points are considered. The effect of the magnetic field may be determined by considering the motion of each ion between collisions with molecules. The rate of increase of the mean square of the distance of any distribution from the axis of z, $d\rho^2/dt$, may be determined by considering the motion of an ion parallel to the plane of xy. Equations are discussed relative to the motion of ions and also to their motions in a magnetic field. When ions are moving in an electric field and a magnetic force H is applied along the axis of z, the motion in that direction is unchanged, but in the directions x and y the velocities are altered. The equations of motion from which the number of ions per cm.^{3} at any point in the gas may be determined when electric and magnetic forces are acting, are given; also an expression for the deflection of a stream of ions from the direction of an electric force when moving under the action of that force. There are several well-known phenomena connected with the magnetic rays that occur in discharge tubes in which remarkable effects are obtained by magnetic forces. The observed effects are qualitatively in accordance with the theory here given, but the conditions under which they are obtained and the system of forces that is called into play are so complicated that an accurate comparison with the theory would not be possible. A. E. G.

1404. *Ion-mobility in Saturated Steam.* **K. Przibram.** (Deutsch. Phys. Gesell., Verh. 14. 14. pp. 709–711, July 30, 1912.)—Continuation of former tests under conditions more favourable [compare Abstracts Nos. 507, 1728 (1909), and 1479 (1910)], such as greater velocity of the vapour and longer periods of observation. As a result it is found that $\overset{+}{u}=1\cdot1$, $\overset{-}{u}=0\cdot95$, instead of the former $\overset{+}{u}=1\cdot0$, $\overset{-}{u}=0\cdot95$. Further data are wanted, particularly in regard to the differences between saturated and unsaturated vapours; these would throw light upon electronic affinity [Franck, Abstracts Nos. 1479 (1910) and 1247 (1912)], the effect of vapours in air, the relation of ion-mobilities in pure vapours, and condensation upon ions in cases of supersaturation. A. D.

1405. *Ionic Velocities from Salted Flames.* **A. Bernini.** (N. Cimento, 3. Ser. 6. pp. 366–367, May, 1912.)—A hydroelectric machine is connected with an electroscope and a vertical metallic plate, on the other side of which a non-luminous gas-jet burns. On working the machine the electroscope attains a steady deflection, governed by the current conveyed by the flame ions. When a sodium or other salt is introduced into the flame the steady deflection is higher than before. This is probably owing to the greater size and slower speeds of the salt ions as compared with the gaseous ions of the burner. E. E. F.

1406. *Recombination of Ions in Carbon Dioxide and Hydrogen at Different Temperatures.* **H. A. Erikson.** (Phil. Mag. 23. pp. 747–752, May, 1912.)—In a previous paper the author showed that the rate of recombination of ions in air at constant density increases as the temperature is lowered [see Abstract No. 1916 (1909)]. This has been confirmed by Phillips [Abstract No. 600 (1910)]. In the present paper Erikson gives the results he has obtained (using the same apparatus as before) with CO_2 and hydrogen. The method consists in measuring Q, the number of ions produced by the rays per sec., and N, the number of ions of the same sign in the gas after the condition has been reached where as many ions are recombining per sec. as are being produced by the rays. The coefficient of recombination (α) was calculated from the relation $\alpha = KQ/N^2$, where K is a constant depending upon the dimensions of the ionisation chamber. With CO_2 the coefficient of recombination of the ions increased as the temperature was lowered from + 100° C. to − 64° C. At 100° $N = 10{\cdot}46$ and $\alpha = 2{\cdot}6$, at − 64° $N = 6{\cdot}95$ and $\alpha = 5{\cdot}89$; N and α being expressed in arbitrary units. In the case of hydrogen (obtained by electrolysis of water) α was also found to increase as the temperature fell: at 28° C. $N = 6{\cdot}14$ and $\alpha = 0{\cdot}45$, at − 64° $N = 4{\cdot}30$ and $\alpha = 0{\cdot}90$, whilst at − 179° $N = 1{\cdot}66$ and $\alpha = 6{\cdot}00$. Thus the value of α at − 179° is 13 times as great as at + 28°. The probable cause of the variation in α appears to be the change in the thermal velocity of the ions as the temperature is altered, as there is a relative velocity above which the ions cannot recombine.

J. J. S.

1407. *Diffusion of Ions in Tubes of Different Materials.* **E. Hensel.** (Phys. Zeitschr. 13. pp. 666–672, July 15, 1912.)—Dry air is the gas employed and the tubes experimented with are made of aluminium, iron, lead, and brass. The effects so obtained are compared with those got with tubes of exactly the same dimensions made of gypsum, wood, glass, and vulcanised rubber. The results show that the material of the tube has no influence on the diffusion of the ions. At ordinary temperatures the electrons being withdrawn are not far removed from the surface: they are accumulated in a layer of thickness less than the free path of the electrons. A. E. G.

1408. *Photoelectric Properties of Thin Metallic Films.* **J. Robinson.** (Phil. Mag. 23. pp. 542–551, April, 1912. Phys. Zeitschr. 13. pp. 276–281, April 1, 1912.)—The work of Kleeman and Stuhlmann [Abstract No. 260 (1911)] was extended by depositing the films at a low pressure on the quartz plates and exhausting immediately after deposition to as high a vacuum as possible. It was found that, as announced by Stuhlmann, the effect for thick films is the reverse of that for thin films, the ionisation produced by emergent light being greater than that due to incident light in the former case. The ratio of emergent to incident effect was, for relative thicknesses of the film amounting to 5, ratio 1·29; 8, ratio 1·12; 18, ratio 1·11; and 55, ratio 0·31. The relative numbers represent minutes of time during which the films were being deposited. The thickness was of the order of 10^{-6} cm. The hypothesis most in harmony with the results is Lenard's view that a certain p.d. is necessary to drive electrons away from the surface. A larger p.d. is necessary to drive electrons away from a film for incident light than for emergent light.

E. E. F.

1409. *Magnetic Rays.* **A. Righi.** (N. Cimento, 3. Ser. 6. pp. 159–176, March, 1912.)—The magnetic rays produced in a Thomson electrodeless ring discharge [Abstract No. 1545 (1911)], probably due to binary neutral combinations of ions and electrons, may also be produced by the action of a magnetic field upon a spark discharge in a vacuum of some hundredths of a mm. Such discharges, which with ordinary arrangements can only be obtained as vague or stratified luminosities, may be obtained by exciting a tube with an influence machine with an external spark-gap in series with the vacuum tube and a large condenser connected in parallel with the spark-gap and tube. The sparks are then only slightly indefinite. Then, on applying a strong magnetic field, rays are seen proceeding from the spark track in the direction of the magnetic lines of force. It is possible also to produce a somewhat similar effect in the stratified positive column, with the aid of a much shorter external spark-gap. Fan-shaped luminous streaks then spread out in the direction of the magnetic lines of force. E. E. F.

1410. *Photoelectric Fatigue and Initial Velocities.* **K. Herrmann.** (Deutsch. Phys. Gesell., Verh. 14. 11. pp. 557–575, June 15, 1912.)—Plates of various metals were scraped in a vacuum of less than 0·0001 mm. Hg, and the photoelectric current was measured immediately afterwards. When glow discharges were carefully avoided, no photoelectric currents were ever obtained with retarding p.d.'s. The current-potential curve always began at the origin of co-ordinates. This was the case with all the metals examined, including Al, Zn, Cu, Ni, and Pt. The vacuum scraping reduced the fatigue, but did not eliminate it. E. E. F.

1411. *Minimum Photoelectric Effect in Potassium.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 13. pp. 468–476, June 1, 1912.)—The authors determined the smallest amount of light capable of producing a measurable electron current in a potassium photoelectric cell. On account of the smallness of the quantities, it was not feasible to take monochromatic light, so they used Ångström's formula for determining the total energy of a Hefner lamp down to a certain wave-length. Down to $\lambda = 550\ \mu\mu$ the energy of the amyl acetate flame of about 800 mm.^{2} luminous area is $1{\cdot}17 \times 10^{-8}$ gm.-cals. per cm.^{2} at 1 m. The photoelectric current was measured by means of a single-fibre electrometer. The max. voltage was 170. The blue and green light was cut off by means of a saturated potassium dichromate solution 1·2 cm. thick. This cut off 75 per cent. of the total energy. The light was further reduced (*a*) by placing a small diaphragm in front of the lamp; (*b*) by two crossed nicols; (*c*) by making the illumination intermittent. The results showed that the minimum luminous energy discoverable was about 10^{-7} erg/sec. cm.^{2}, the photoelectric current being then of the order of 10^{-15} amp. E. E. F.

1412. *Photoelectric Properties of Aluminium and Magnesium.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 14. 10. pp. 546–554, May 30, 1912.)—Surfaces of Al and Mg, produced by distillation in a vacuum, give when freshly prepared an electronic emission commencing between $\lambda = 365$ and 405 and increasing down to 230 $\mu\mu$ while the incident energy remains the same. After a time the long-wave limit creeps up to greater wave-lengths, Al being then sensitive up to 700 $\mu\mu$, and Mg beyond 1000 $\mu\mu$, at which point the radiation from a 16-c.p. glow lamp penetrates 0·38 mm. of ebonite. While this shifting is taking place a maximum of electronic emission appears at 260 $\mu\mu$. This maximum does not appear to have any connection with a selective photo-effect. E. E. F.

1413. *Photoelectric Phenomena and Absorption of Light.* **G. Reboul.** (Comptes Rendus, 155. pp. 37–39, July 1, 1912.)—When a plate of Cu is plunged into dilute Br-vapour, it becomes covered with a film of copper bromide, the colour of the film depending on its thickness. Measurement of the emission of negatively-charged particles from such surfaces under the influence of ultra-violet light shows the emission to be least when the colour of the film is violet, minimum absorption of light corresponding to minimum emission. The absorption of light increases with the thickness of the film of bromide up to a thickness of 1400 $\mu\mu$, beyond which there is very little change. [See also Abstract No. 671 (1912).] W. H. St.

1414. *Photo-electricity and Light Quanta.* **O. W. Richardson.** (Science, 36. pp. 57–58, July 12, 1912.)—Deduces the relation between the number and kinetic energy of the electrons emitted by different metals under the influence of light, on the one hand, and the frequency of the light and the position of the metals in the voltaic series, on the other, from theoretical considerations. The author obtains the following four equations:—

(1) $N_v = 0$, for $0 < hv < w_0$.
(2) $N_v = A_1R^2hv^2 . (1 - w_0/hv)$, for $w_0 < hv < \infty$.
(3) $T_m = hv - w_0$, for $w_0 < hv < \infty$.
(4) $T_v = s\,(hv - w_0)$, for $w_0 < hv < \infty$.

In these equations, N_v is the number of electrons emitted in unit time per unit area of a metal in presence of unit density of isotropic radiation of frequency v, T_m is their max. kinetic energy, T_v their mean kinetic energy, h Planck's radiation constant, A_1 is a constant characteristic of the material, w_0 the internal part of evaporation of a single electron at absolute zero, R the gas constant for a single molecule, and s is the ratio between the proportion of the incident energy which is absorbed and the proportion of the incident matter or electricity which is absorbed, from the stream of electrons which returns to the body in a state of thermal equilibrium. If $v_0 = w_0/h$, it can be shown that the experimental results announced by Compton and the author [see next Abstract] confirm equations (1), (3), and 4. Equation (2) has not yet been experimentally tested. These laws are capable of extension to Röntgen and γ-rays, and even to the reversible formation of gaseous chemical products under the influence of radiation. The above equations have been derived without making use of the hypothesis that free radiant energy exists in the form of "light-quanta," unless this hypothesis implicitly underlies the assumption (A) that Planck's radiation formula is true, (B) that the number of electrons is proportional to the intensity of monochromatic radiation. Planck has recently shown that the unitary view of the structure of light is not necessary to account for (A), and it has not yet been shown to be necessary to account for (B). Hence the confirmation of equations (1), (3), and (4) does not necessarily involve the acceptance of the unitary theory of light. E. E. F.

1415. *Velocity of Electrons liberated by Ultra-violet Light.* **K. T. Compton.** (Phil. Mag. 23. pp. 579–593, April, 1912.)—Shows that, in determining velocities of electrons projected under the action of light, the contact p.d. between any plates consisting of different metals must be taken into account. This may amount to as much as 1 volt, and is thus a large portion of the p.d. which electrons can overcome by virtue of their velocity (maximum about 6 volts). This fact modifies some of the conclusions derived from measurements of electronic velocities. When the contact p.d. is allowed for, it is found that different metals, under the action of ultra-violet light, give off electrons with practically equal velocities. Yet a small real difference seems to exist, for the differences between the current-voltage curves for the different metals are too large to be attributed to experimental error. The fact that some of the curves are steeper than others suggests that there may be selective absorption of different wave-lengths by the metals. The shift of the curves with time is accounted for by the time-changes in the contact p.d.'s between the emitting and receiving plates.

E. E. F.

1416. *Emission of Charges in Vacuo.* **E. Henriot.** (Le Radium, 9. pp. 189–195, May, 1912.)—J. J. Thomson found [Abstract No 2245 (1905)] that the alkaline metals, *in vacuo*, produced a small emission of negative particles when kept in the dark. The experimental results are very greatly dependent upon (1) a suitable degree of vacuum and condition of the metallic surface, (2) scrupulously perfect protection of the interior from electrostatic influences, (3) complete protection against light. Modifying the details of experiment accordingly, the author concludes that the J. J. Thomson-effect seems to exist, but ought not to exceed 10^{-16} amp. per sq. cm. if we avoid magnifying the results by shock-ionisation. Hydrogen has an effect upon the surface of the metal, partially regenerating it and increasing the emission of charge. A. D.

1417. *Emission of Electricity from Carbon at High Temperatures.* **J. A. Harker** and **G. W. C. Kaye.** (Roy. Soc., Proc. Ser. A. 86. pp. 379–396, April 25, 1912.)—In some electric-furnace experiments it was noticed that carbon was transferred from the carbon walls of the furnace to the surfaces of rare-earth tubes that were being baked. The work of previous investigators showed that the electrification of an incandescent solid depends on (1) the nature and temperature of the solid, and (2) the nature and pressure of the surrounding gas. The phenomenon was studied by providing two insulated electrodes within, and co-axial with, a carbon tube heated by alternating current, this tube being surrounded with lampblack. Or a graphite tube was employed cut in the form of a spiral. Acheson graphite was used, one analysis showing 99·8 per cent. carbon. The carbon tubes were supplied by the General Electric Co. and usually contained a little under 1 per cent. of foreign matter. One electrode was hollow, thus permitting temperature readings by an optical pyrometer. The pressure was atmospheric, and generally nitrogen was passed through the apparatus ; a current of gas was necessary above 1800° to remove the slight fog from impurities. When small potentials (up to 6 or 8 volts) were applied to the electrodes no appreciable current could be detected below 1400° C., but at higher temperatures the current rose rapidly, reaching a value of several amps. (maximum recorded, 10 amps.) at 2000° C. The relation between current and applied p.d. is linear, whereas that between current and temperature is exponential. Increasing the gap between the electrodes did not increase the resistance very much because the surrounding carbon tube acted as a shunt. Ionisation currents persisted after the alternating heating current was cut off. Continuous current for heating caused asymmetry, the amount of the ionisation current depending on the direction of the applied p.d. ; also the direction of the current was independent of the applied p.d., and it was found that currents were recorded even when this p.d. was cut out—doubtless due to the greater electrical emissivity of the negative end of the furnace. Experiments were also made with one of the electrodes movable so that a difference of temperature might be created between the electrodes, and it was found that the cooler electrode was positive. Non-electric heating gave similar results. In order to obtain steady currents (with no applied p.d.) a water-cooled insulated brass tube was arranged along the axis of the furnace and a co-axial insulated carbon tube which received its heat from the furnace. The radial distance between the electrodes was about 5 mm. and an atmosphere of hydrogen was used. As the furnace was heated up a small current at first flowed, such as would be produced by positive ions crossing from the hot to the cold electrode. The current then reversed, reaching a maximum of nearly 0·6 milliamp., subsequently falling and then rising progressively. The maximum is attributed to the volatilisation of silicon and other impurities in a new tube; on a second heating it does not occur. On cooling, the brass tube was found to be thickly coated with carbon. Under conditions allowing a larger temperature-difference a current of 20 milliamps. was obtained. The results depend slightly on the atmosphere used, and the admission of a new gas often gives a momentary increase of ionisation. By using the furnace tube as one electrode and a water-cooled brass tube sheathed with a carbon tube as the other electrode a current as high as 0·8 amp. was obtained. The authors are unable to say to what extent the results may be due to impurities in the carbon; so far no "fatigue" has been noticed. The experiments (without applied p.d.) are an interesting example of the Thomson-effect for a vapour; the currents brought about by the potential gradient flow in the direction opposite to the heat-flow. W. R. C.

1418. *Electrons projected from Lime.* **H. Schneider.** (Ann. d. Physik, 37. 3. pp. 569–598, March 8, 1912. Extract from Dissertation, Berlin.)—An experimental determination of the energy of projected electrons by the method devised by Wehnelt and Jentsch [Abstracts Nos. 1079, 1080 (1909)], carrying it to higher temperatures. A Pt-Ir wire 12·5 cm. long and 0·03 cm. in diam. was covered with CaO to an effective area of 1·181 cm.^{2}. This was made incandescent at a temperature of 1400° C. in a high vacuum and charged to various voltages. The energy of projection of the electrons is determined from the difference between the energy supplied and that radiated or conducted away as heat. The number of electrons projected is determined from the saturation current between the wire and a surrounding brass cylinder; the charge is assumed to be $4{\cdot}69 \times 10^{-10}$ e.s. unit. The energies found by these measurements were always greater than those found from Richardson's formula. Compared with the energy of a black body of the same temperature, the energy of projection rises much more rapidly with the temperature. Independent measurements were made of the velocity of projection of the electrons from CaO, by bringing it to incandescence by means of concentrated beams from an arc lamp. It was found to be $8{\cdot}41 \times 10^7$ cm./sec. E. E. F.

1419. *Electric Currents in Air at Atmospheric Pressure.* **A. Anderson** and **H. N. Morrison.** (Phil. Mag. 23. pp. 750–752, May, 1912.)—Townsend, citing experiments by Almy, assumes that it is impossible for an electric current to pass at ordinary pressure through the air space between two electrodes when the p.d. is as low as 30 volts even if the distance apart is less than the wave-length of sodium light. Almy used spherical electrodes of about 0·007 cm. diam. Thus the area of an electrode was about 1/67th of a square mm., and even for currents of higher p.d. and for distances between the plates much greater than λ for sodium light, they might not be detected with such small electrodes. Probably such currents are due to the motion of electrons and would be proportional to the area of surface whence the electrons come. The authors have made experiments using parallel circular copper plates of area about 7 sq. cm. After using precautions to eliminate sources of error the authors found a decided current with a distance apart of plates of about 0·005 cm. and p.d. about 30 volts. By joining to the pole of a battery the lower plate B was made positive and the upper A earthed. Then when both plates are earthed for a short time and A afterwards insulated and joined to an electrometer, A will charge up negatively, behaving as if it were a plate of another metal electropositive to B when both are immersed in ionised air. This charging-up must be due to a contact difference and to the presence of carriers, both produced by the previous current through air. Leakage through the insulating supports would cause positive charging. There is no such effect when the plates are put into metallic contact and a current allowed to pass from one to the other. This induced contact difference is not permanent but gradually diminishes and disappears. The authors suggest that photoelectric fatigue produced by exposure to ultra-violet light is really wholly or in part an induced contact difference, for this latter occurs on exposure of metals to ultra-violet light. It was also found that currents can be produced between two plates under the action of their contact difference alone. Let R_1 be the resistance of the plates, R_2 the resistance of the air between the plates (assumed constant), C the capacity of the plates and electrometer, and V the contact difference, then the potential v shown by the electrometer at a time t after the insulation of the quadrants joined to A is given by—

$$v = \frac{R_1 V}{R_1 + R_2}\left(1 - e^{-\frac{R_1 + R_2}{CR_1R_2}}\right)$$

When R_1 is very great in comparison with R_2 the final value of v is V, the contact difference. In general the final value of v is $R_1V/(R_1 + R_2)$. J. J. S.

1420. *Dielectric Effects in Gases.* **G. Millochau.** (Comptes Rendus, 154. pp. 1695–1697, June 17, 1912.)—Aubertin found, in his experiments on condenser discharges, that with a high liquid resistance in the discharge circuit, a residual charge is left on the condenser [see Abstract No. 1089 (1912)]. Millochau also noted the same phenomenon in the course of work on the discharge in Geissler tubes; further investigation has shown that the difference of potential V_1, necessary to start the discharge in a spectrum tube, is slightly variable according to the mode of discharge; there exists also an inferior limit V_2 of the potential, for which the discharge ceases. The value of V_2 is very variable in certain cases, due to the appreciable time (about 10^{-4} sec.) of reconstitution of the dielectric. A. W.

1421. *Causes of Glow-electrode Effect.* **K. Fredenhagen.** (Phys. Zeitschr. 13. pp. 539–540, June 15, 1912.)—A continuation of work previously dealt with [Abstract No. 904 (1912)]. The author has shown that the emission of negative electrons from heated metals is probably due to a reaction effect [see Abstract No. 1738 (1911)]. It is here shown that a similar explanation holds for the glow-electrode effect. CaO and the other oxides which show the Wehnelt-effect are little susceptible to "reactions." But with the Wehnelt electrode the oxide is in a thin layer on Pt-foil, and at high temperatures the oxide conducts; the conduction of the oxide is, however, electrolytic, and so is associated with separation of Ca and O. The potential gradient in the glow-electrode is very considerable, and hence it is probable that the cause of the emission of electrons is to be sought in the electrochemical conditions which prevail. Research confirmed this view, for when heated in an electric oven the emission from a certain electrode was only about 1 per cent. of that at corresponding temperatures when heated by means of a current. Further experiments are in progress. A. W.

1422. *Generation and Causes of the Electrodeless Ring Discharge.* **W. Winter.** (Phys. Zeitschr. 13. pp. 442–446, May 15, 1912.)—Details of apparatus with particulars relative to experiments are given, the results of which lead to the following conclusions:—The view expressed by E. Lecher and A. Steiner that the ring discharge is due in the first place to the ionisation produced by the p.d. of the coil but that the arrangement of the ions is a consequence of the alternating magnetic field, is confirmed. The disappearance of the ring discharge at higher vacua is not due to the number of molecules being reduced so that the ionisation is insufficient, but to the fact that at very low pressures the dark space is much increased in size. This action of the dark space is much more apparent with narrow vessels, the ring discharge disappearing at higher pressures with narrow tubes than with wide ones. A. E. G.

1423. *New Form of Metal Arc in Vacuum.* **G. Rümelin.** (Phys. Zeitschr. 13. pp. 451–453, May 15, 1912.)—The lamp is an improvement on that designed by Janicki [Abstract No. 1878 (1909)]. A vertical glass tube is closed by a plane glass window at the top, and at the bottom by a glass stopper through which pass three wires. The two outer wires serve as leads to a Wehnelt kathode—an oxide-covered Pt-strip bent into a semicircle. The centre wire is surrounded by a small porcelain tube at the top, in which a piece of the metal, whose spectrum is to be examined, is placed. This serves as anode and it is fixed at the centre of the semicircular Pt-strip. A pressure of 220 volts between anode and kathode is employed. Under this potential gradient the kathode rays bring the anode metal to incandescence and a spectrum of the metal may be obtained, which is made up of very sharp, intense lines. The tube is evacuated by a Gaede pump and is cooled by a water-jacket. Its greatest thickness is 3·5 cm., and thus powerful magnetic fields may be brought to bear on the arc, if desired. T. P. B.

1424. *Ignition of Electric Arc.* **A. Occhialini.** (N. Cimento, 8. Ser. 6. pp. 220–232, March, 1912.)—The author's previous work [Abstracts Nos. 1938 (1909); 1109 (1910); 1557 (1911); 562, 563 (1912)] has been extended to stronger currents by means of the new plant of the Pisa Physical Institute, consisting of two dynamos each giving 2000 volts and 1·5 amps., excited by the town circuit of 220 volts. It results from the new experiments that the impossibility of obtaining an arc with a cold kathode only refers to the lower e.m.f.'s. The only essential condition for the ignition of the arc is that a sufficiently strong current should be established between the electrodes. The discharge potential is, however, always higher when the kathode is cold. E. E. F.

1425. *Relation between the Loss of Electrode Material in the Spark-gap of an Oscillatory Circuit and the Quantity of Electricity Transported.* **H. R. v. Traubenberg.** (Phys. Zeitschr. 13. pp. 415–421, May 15, 1912.)—The loss in electrode material is determined by weighing. To determine the quantity of electricity, Q, transported across the spark-gap, it is necessary to know in what manner the oscillation dies away. If in an exponential manner, then $Q = CV_0 \coth (d/4)$ for each oscillation train, C being the capacity in the circuit, V_0 the initial p.d., and d the logarithmic decrement. If the oscillation falls off linearly, as is approximately the case when the damping is determined solely by the spark-gap, Q may have a much smaller value than this. In the experiments there is a considerable amount of ohmic resistance in the circuit and the oscillation is therefore supposed to fall off exponentially. If some law analogous to Faraday's law for electrolysis holds, then

$\phi = \mathrm{A}b\mathrm{CV}_0 \coth (d/4)/\mu$ should be a constant, μ being the loss in weight of the electrodes, A the gm.-atom of the substance of the electrodes, b the number of oscillation-trains per sec. The metals used are Mg, Zn, Th, and the discharge takes place in oxygen and in nitrogen. The results show that in both gases ϕ is a constant, its value in oxygen being 2 × 110,000 coulombs per sec. and in nitrogen 4 × 100,000. These values are approximately 2 and 4 times the value obtained by electrolysis. The discrepancy may arise from the fact that the metals are assumed to be univalent; that the oscillation is supposed to die away in an exponential manner, and that the gas surrounding the gap takes part in the transport of the electricity. T. P. B.

1426. *Oscillatory Discharges.* **G. Millochau.** (Comptes Rendus, 155. pp. 147–149, July 8, 1912.)—A battery of 7500 accumulator cells is used for these experiments. So long as the potential is below a certain limit the discharge is continuous and gives at the beginning the characteristic spectrum of that discharge, but at a definite potential the spectrum corresponds to the normal oscillatory discharge. If the potential is still further slightly increased, a second, faint component appears constituting the second phase of the first oscillation: the tube has still an unsymmetrical appearance, but a slight negative glow shows at the positive electrode and a faint positive point at the negative. When the potential is sufficient the second component becomes almost equal in brightness to the first, and after this the tube is symmetrical. Tables are given in which the observed results are compared with those calculated by the use of an empirical formula. The accord is very satisfactory. It appears that the number of oscillations increases indefinitely with the potential, and for a given potential it increases with the capacity and decreases with the explosive distance. A. E. G.

1427. *Overtones of Poulsen Oscillation Circuit and Measurement of Wave-length.* **R. Lindemann.** (Deutsch. Phys. Gesell., Verh. 14. 12. pp. 624–633, June 30, 1912.)—The overtones in a Poulsen oscillation circuit may be intensified by increasing the capacity at the expense of the self-induction and by diminishing the arc current. Where overtones of a high frequency are desired they may be obtained in a second oscillation circuit placed in parallel with the arc, the natural period of this circuit being the high frequency desired, and the original circuit being so adjusted that its natural period is a complete multiple of that of the second circuit. The overtones of the Poulsen circuit may be used in particular to check the frequency scale of a wave-meter or to extend the same in either direction. Experimental results are given to show how accurately the fundamental frequency may be determined from the overtones, an accuracy of 1 in 1000 being obtained throughout. Overtones up to the 43rd are employed, and wave-lengths as short as 140 m. are obtained. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1428. *Potential Effect in Selenium and Antimonite.* **C. Ries.** (Ann. d. Physik, 36. 5. pp. 1055–1065, Dec. 21, 1911.)—Luterbacher [Abstract No. 662 (1911)] showed that the fall in the resistance of Se on applying higher p.d.'s is not due to heat. This was confirmed by measurements with a selenium bridge (or "cell") having a metallic temperature coefficient of resistance. It showed an increase of conductivity from 220 to 307 in arbitrary units on increasing the applied voltage from 2 to 110. On applying the same voltages for 5 min. the conductivities became 222 and 318 respectively. This phenomenon the author terms "dark inertia." The creeping up of the conductivity is imperceptible after the first 10 min. at low voltages, but lasts longer than 20 min. at 110 volts, and recovery takes longer than 30 min. The increased conductivity is the same in both directions, and care was taken to eliminate polarisation and thermoelectric effects. Antimonite crystals from Shikoku, Japan, also show the potential effect. The conductivity increases from 11 at 4 volts to 72·7 at 110 volts. There is also the "dark inertia" and gradual recovery as seen in selenium. Curves are given showing the dependence of the potential effect upon temperature. E. E. F.

1429. *Depth of Light-action in Selenium.* **F. C. Brown.** (Phys. Rev. 34. pp. 201–214, March, 1912.)—The effective depth of penetration of light in a film of Se is determined by a comparison between light-action and temperature-action upon the conductivity. It is assumed (and supported experimentally) that the action of light and heat is similar in respect of the ratio of the change of conductivity to the actual conductivity. The only experimental difference between them is that light is stopped at a certain depth, whereas heat acts throughout the substance. If this view is correct, then curves plotted with C and ΔC as co-ordinates, where C is the conductivity, should be identical for Se acted on by heat and Se completely penetrated by light. The extent to which light penetrates into a given film may then be determined by comparing the values of C for a given ΔC in the case of light and heat respectively. The measurements were made with a Giltay selenium bridge, in which the Se layer was successively filed thinner. The depth of effective penetration was found to be about 0·014 mm. This is not necessarily the depth to which the light itself penetrates, and is probably very much greater. The effective penetration does not appear to vary with the conductivity. E. E. F.

1430. *Saturation Currents in Selenium.* **F. Kaempf.** (Phys. Zeitschr. 13. pp. 689–694, Aug. 1, 1912.)—Investigates the possibility of a superior limit to current density in selenium. The conductivity equals nue, where u is the mobility of electrons in Se, e the electronic charge, and $n = (N/a)^{1/2}$, N being the number of atoms dissociated per unit volume and unit time, and a the coefficient of recombination, both referred to the transition layer between kathode and Se, where electrons have to find their way into the Se against the attraction of their images in the kathode. When all the available molecules are dissociated in the transition layer, N may be reduced at higher applied voltages, and the current will be saturated. The author looked for this saturation in a selenium bridge between two portions of a Pt-film deposited on glass and divided in two by a scratch 0·04 mm. in width. The Se was deposited by kathode disintegration. The resistances of the bridges were 10^7 and 10^9 ohms. Voltages up to 300 were applied by means of a ballistic contrivance for about 0·05 sec. A saturation current was observed at a very high potential gradient, viz., 12,000 volts/cm. Just before that point was reached, the conductivity showed a decrease of conductivity with increasing voltage, *i.e.*, a negative potential effect on resistance. E. E. F.

1431. *Conduction of Electricity at Contacts of Dissimilar Solids.* **R. H. Goddard.** (Phys. Rev. 34. pp. 423–451, June 1912. Electrician, 69. pp. 778–781, Aug. 16, 1912. Abstract.)—The authors experiments consisted in trying a number of rectifying substances against various metals, in order to see if any general conclusions could be drawn. A small d.c. voltage was applied and then reversed in direction, the p.d. across the contact being measured and also the current passing. Other experiments were made to investigate permanent changes in conductance; the effect of large currents; effects in high vacua and in various gases; the conductivity of metal filings *in vacuo;* oscillograms of rectifiers at high frequencies with the aid of the Braun tube. The original pages must be referred to for the results, which cannot be dealt with in a brief abstract; but the following are the author's main conclusions:—(1) Pure elements give little or no rectification against pure metals, unless oxygen (or inactive gas) is present. (2) Rectification, other than that due to presence of oxygen, occurs at contacts of impure elements or chemical compounds. (3) The phenomenon is due, primarily, to the presence or formation of a film at the contact. (4) Solid rectifiers are, apparently, analogous to the aluminium valve, or electrolytic rectifier. In this rectifier a solid film is produced and large ions are packed against it, giving a back e.m.f., when the current passes in one direction, whereas smaller, negative, ions pass freely through the film when the current is in the opposite direction. The greatest point of dissimilarity is the continued breaking down of the resisting film, in the case of solid rectifiers, probably due to heating. (*a*) The hysteresis effect observed by Pierce with carborundum, for the first few reversals, together with the fact, observed by the writer, that Te cleaned *in vacuo* required a few reversals before showing good unilateral effect, when oxygen was admitted, are both analogous to the slow building-up of resistance with direct current, for a fresh plate in the Al valve, before an alternating current has been applied. (*b*) The oscillogram at 410,000 frequency suggests the building-up of a back e.m.f., which gives a slight additional current at the moment the current is reversed. This conclusion is, however, based upon a single experiment. L. H. W.

1432. *Conductivity of Sodium Vapour.* **L. Dunoyer.** (Comptes Rendus, 155. pp. 144–147, July 8, 1912.)—Many phenomena observed in connection with the vapours of the alkaline metals lead to the supposition that those vapours are relatively good conductors of electricity. The object of the present experiments is to ascertain the extent of this conductivity. In principle the experimental arrangements consist of the formation of sodium vapour by heating the metal to 250°–400° C., and then passing the vapour through an electric field to be afterwards caught in a Faraday cylinder. It is found that whatever may be the sign and intensity of the electric field no charge is given to the Faraday cylinder by the sodium molecules, from which it is concluded that the conductivity of pure sodium vapour does not differ in order of magnitude from that of an ordinary gas. A. E. G.

1433. *Conductivity of Electrolytes.* **O. Scarpa.** (Elettricistà, Rome, 1. Ser. 3. pp. 137–139, May 1, 1912.)—Several experiments are described in which it is attempted to demonstrate and measure the conductivity of electrolytes without the use of immersed electrodes. One of these, suggested by Kahlenberg, consists in having two successive transformers linked together by a liquid conductor which forms the secondary of one transformer and the primary of the other. The liquid conductor is a rubber tube filled with KCl solution of maximum conductivity. On inserting a telephone in the secondary of the second transformer a sound is heard, mostly due to transmission of an alternating current through the electrodeless liquid. Attempts were made to measure the conductivity of the electrolyte by compensating its conductivity by means of that of a wire wound in the opposite direction, but no satisfactory results were obtained. A useful lecture demonstration was devised by leading an alternating current through a circuit containing a telephone and two electrolytic vessels. The latter were partly covered with tin-foil to make connection with the circuit. The vessels themselves were joined by means of a siphon filled with electrolyte. A loud-speaking telephone makes the current audible to the audience. E. E. F.

1434. *Electrical Properties of Copper-Tin Alloys.* **R. Ledoux.** (Comptes Rendus, 155. pp. 85–87, July 1, 1912.)—Curves are plotted showing the variation in specific resistance, temperature-coefficient, and thermoelectric power, with changing composition of the alloys. There are definite breaks in the curves for a composition corresponding to Cu_3Sn, and some indication of a break corresponding to Cu_4Sn, but no evidence of any compound CuSn. W. H. St.

1435. *Comparing Capacities at Various Frequencies.* **A. Campbell.** (Phys. Soc., Proc. 24. pp. 181–184; Discussion, pp. 184–185, June 15, 1912. Electrician, 69. pp. 690–691, Aug. 2, 1912. Abstract.)—For the accurate determination of a capacity in terms of a resistance and a frequency Maxwell's commutator method is very convenient. The author extends the method by making use of a rotating double commutator. This is used to charge and short-circuit each condenser simultaneously, the resistances and the frequency being so chosen that the charge and discharge are practically complete for both condensers in each cycle. The advantages of the method are that alternating current is not required, and as a direct-current galvanometer is used a very high sensitivity can be obtained. In the *discussion*, **J. A. Fleming** said that for many years he had used a rotating double commutator for measuring small capacities. A. R.

1436. *Speaking Incandescent Electric Lamps.* **K. Ort** and **J. Rieger.** (Phys. Zeitschr. 13. pp. 561–562, June 15, 1912.)—The secondary of a microphone transformer in series with a capacity is placed across the terminals of a 100-c.p. osram lamp, which is lighted off a 150-volt circuit. A choking coil is inserted in the lighting circuit. The lamp reproduces faintly speech which is transmitted to it from the microphone. The effect is attributed to the varying temperature of the filament, which sets the thin glass envelope in vibration. Lamps of 16-c.p. and 32-c.p. did not respond, as their glass envelopes are too thick. T. P. B.

1437. *The Maximum Sensibility of a Duddell Vibration Galvanometer.* **H. F. Haworth.** (Phys. Soc., Proc. 24. pp. 230–236; Discussion, p. 237, June, 1912. Electrician, 69. pp. 731–732, Aug. 9, 1912. Abstract.)—To improve the sensibility of a Duddell vibration galvanometer, particularly at high frequencies, the permanent magnets were replaced by a field-magnet system, similar to the Duddell oscillograph. Experiments were undertaken to see how the sensibility of the instrument as an ammeter and a voltmeter varied with the flux density in the gap. As would be expected, the sensibility of the instrument as an ammeter increases as the flux increases, the limitation of sensibility being the limitation of the flux due to saturation of the iron. As a voltmeter, however, for frequencies up to 500 or 600 (depending on the length of the wire), the sensibility increases from zero up to a well-defined maximum, after which any increase of flux decreases the sensibility of the instrument.

If the apparent resistance V/A be calculated from the two curves, it is found that the max. sensibility of the galvanometer, used as a voltmeter, is attained when this apparent resistance is twice the ohmic resistance of the instrument. This means that the flux in the gap should be so adjusted that at any time the back e.m.f. of the coil is equal to and in phase with the ohmic resistance drop. In practice this is conveniently done by varying the flux until for a certain want of balance in the bridge circuit, a maximum deflection is obtained. Experiments were also conducted *in vacuo*, the results of which seem to show that the greater part of the mechanical work produced was used in overcoming the molecular friction of the system. In the *discussion*, **A. Campbell** remarked that he had convinced himself that the chief energy loss in his vibration galvanometer was in the elastic hysteresis of the wires. W. C. S. P.

1438. *Sensitive Electrometer.* **G. Hoffmann.** (Phys. Zeitschr. 13. pp. 480–485, June 1, 1912.)—The author describes in detail the construction and advantages of a new, very sensitive electrometer which is capable of measuring the ionisation due to a single α-particle. In sensitiveness it resembles the Dolezalek electrometer, but it possesses approximately only $\frac{1}{10}$ of its capacity. The instrument is essentially a Hankel electrometer with the same relative position of fixed and movable surfaces that a quadrant electrometer has. It has a constant zero and is easily portable. E. M.

1439. *Selenium Bridges.* **P. Jenisch.** (Elektrochem. Zeitschr. 19. pp. 61–63, June, 1912.)—Describes a form of selenium "cell" prepared by depositing Pt on a non-conducting surface, dividing it into two conducting portions by fine incisions, and covering the surface with Se. [This construction has been in use for some years.] The voltage can be raised to 100, and the diam. to 30 cm. The inertia is determined by an apparatus in which the Se bridge is intermittently illuminated by a rotating mirror connected with a synchronous commutator, which reverses the current twice during each revolution of the mirror. The deflection of the galvanometer thus shows the extent to which the Se conducts better in the light than in the dark, as its deflection is due to the difference between the light and dark currents. E. E. F.

1440. *An Electrostatic Quantometer.* **R. Beattie.** (Electrician, 69. p. 457, June 21, 1912.)—An electrometer may be used either as a voltmeter or, with insulated quadrants, to measure electrostatic charges. The idea is brought forward to supplement an analogy between an electrometer and an alternating-current moving-coil galvanometer. [See Abstract No. 1497 (1910), also Nos. 736 (1908) and 1108 (1912)]. G. E. A.

ALTERNATING CURRENTS AND MAGNETISM.

1441. *Rectification of Unsymmetrical Currents.* **H. Rohmann.** (Phys. Zeitschr. 13. pp. 694–699, Aug. 1, 1912.)—If an alternating p.d. $V = \cos \nu_1 t - \cos \nu_2 t$ acts upon a conductor which does not obey Ohm's law, the d.c. component depends upon the ratio of the two frequencies. If ν_1 is permanent and ν_2 is varied, maxima of the d.c. component are found at certain values of ν_2. The author investigates the relations between the position and amount of the maxima and the characteristic of the conductor $i = f(V)$, and specifies a simple method of tuning a condenser circuit to half or double the frequency of another. E. E. F.

1442. *Coils with Low Damping.* **M. Vos.** (Deutsch. Phys. Gesell., Verh. 14. 14. pp. 683–700, July 30, 1912.)—The paper is theoretical. The problem under discussion is: Given a certain frequency and self-induction, to construct a coil to give least damping. Single-layer coils of solid wire are considered. It is shown that in coils of this kind there is a ratio of diam. of coil to length of coil, which gives minimum damping, the ratio being about 2·5. With high-frequency oscillations and round wire the damping is a minimum when the ratio of diam. of wire to pitch of turn is 0·23. When the wire is rectangular in section, the length c of the side of the wire measured in the direction of the radius of the coil should be so chosen that $c = 3/4\pi\sqrt{\sigma n}$, where $\sigma =$ specific conductivity, and $n =$ frequency. If the cross-section of the wire is fixed, c should be made equal to $2{\cdot}1/4\pi\sqrt{\sigma n}$. In this case it is shown also that there is a ratio of the dimension c of the wire as measured in the direction of the radius of the coil to that b as measured in the direction of the length, which gives minimum damping and that this ratio depends upon the frequency in such a manner that if the frequency is low c should be greater than b, but *vice versa* when the frequency is high.

T. P. B.

1443. *Geometry of Magnetic Curves.* **E. Cominotto.** (N. Cimento, 3. Ser. 6. pp. 177–190, March, 1912.)—The equation $\rho = (1 + 3\cos^2\theta)^{\frac{1}{2}}$ represents in polar co-ordinates the locus of the points whose distances from the centre of the magnetic meridian of unit radius represent the magnetic intensities at the corresponding latitudes, the magnetic moment of the elementary magnet at the centre being unity. The author gives a geometrical construction by means of which the direction and intensity of the force at any point can be rapidly determined. E. E. F.

1444. *Weiss's Theory of Ferromagnetism.* **J. Kunz.** (Phys. Zeitschr. 13. pp. 591–594, July 1, 1912.)—P. Weiss, by the introduction of the idea of the molecular magnetic field, has been enabled to explain many magnetic phenomena of pyrrhotine. He suggested that iron is built of elementary crystals possessing similar properties to pyrrhotine, and that in unmagnetised iron the vector magnetisation is equally distributed in all directions. On this assumption it is possible to offer some explanation of the hysteresis actually found, but the author of the present paper shows by calculation that this theory is not at present in good harmony with experimental data. If we attempt to ensure reasonably correct estimations of the hysteresis losses corresponding to inductions of 7000 to 12,000 units, the values corresponding to lower inductions are grossly in error. A. D. R.

1445. *Molecular Theory of Magnetism in Solids.* **W. Peddie.** (Roy. Soc. Edinburgh, Proc. 32. 3. pp. 216–246, 1911–1912.)—The author, having worked out and evaluated expressions for the internal fields acting on the poles of co-directed molecular magnets in a cubic arrangement, has compared the results with Weiss's observations on magnetite. He finds in particular that the cubic arrangement of most open order of the molecular magnets cannot, while that of the homogeneous closest-packed order can, give results in agreement with the observed facts. The present paper (which is mainly mathematical and cannot be given in abstract) is a general development of the theory and an application of the results, especially to the cases of magnetite and pyrrhotine and to the general question of the dependence of magnetic quality upon molecular configuration. A. D. R.

1446. *Transverse Induction Changes in Demagnetised and Partially Demagnetised Iron.* **J. Russell.** (Roy. Soc. Edinburgh, Proc. 32. 3. pp. 292–314, 1911–1912.)—This paper describes an investigation of the æolotropy of iron demagnetised by the method of decreasing reversals. It is found that during the earlier stages of induction the permeability is greater to the reapplication of a magnetising force in the same direction—whether positive or negative—as that used in the immediately preceding demagnetisation process, than to a force with a transverse component. The hypothesis was formed that, on the completion of the demagnetising process by decreasing reversals of force along OX, a preponderance of molecules might set equatorially in the YZ-plane. If the subsequent magnetising force be in a line OR, making an angle θ with OX, the total turning moment on the molecules would be a minimum for $\theta = 90°$. The paper gives full details of an investigation of the induction changes which occur at right angles to the magnetising field when the iron has been previously (*a*) demagnetised by decreasing reversals of a force having a transverse component, (*b*) left residually magnetised by a method of partial demagnetisation by decreasing reversals of a force having a transverse component. The results of the first series of experiments are in harmony with the supposition of a preponderance of molecules within a broad equatorial belt in reference to the demagnetising (polar) force. When iron is left residually magnetised by the method of partial demagnetisation by reversals, the displacement in either direction of the broad equatorial belt, found to be distinctive of complete demagnetisation, can be readily traced in the results of the second series of experiments. A. D. R.

1447. *Electric Behaviour of Certain Sulphides and Oxides.* **J. Koenigsberger.** (Phys. Zeitschr. 13. pp. 281–284, April 1, 1912.)—This paper deals with the behaviour of FeS and FeS_2, the conclusions reached being as follows:—The semi-conductors in question exist in a strongly paramagnetic and crystallographically stable α-modification at low temperatures, and in a weakly paramagnetic stable β-modification above a certain temperature. The electric conductivity of the pure substance changes by heating from the α to the β state discontinuously and irreversibly. The paramagnetism of the pure substance changes continuously, though at the critical temperature very rapidly, and this change is reversible. E. H. B

1448. *Inversion of the Hall-effect in Bismuth.* **J. Becquerel.** (Comptes Rendus, 154. pp. 1795–1798, June 24, 1912.)—On examining the Hall phenomenon in metals the deviation of the equipotential lines takes place in the case of most metals in a direction opposite to that of the rotation of the Amperian currents corresponding to the magnetic field. The effect is then called negative. With other metals (Fe, Zn, Cu, Te) the effect has a positive sense. Bismuth shows a specially intense effect, hitherto taken to be the best example of a negative Hall-effect. From the experiments described in the present paper it would appear that in a field sufficiently intense, and above all at low temperatures, the Hall phenomenon in Bi changes sign and seems to be the resultant of two phenomena of different natures. The consequences of these facts are very important, in view of the theories chiefly accepted at present. The method employed in the experiments was that of Hall, consisting in finding by trial two points on different sides of the axis of a longitudinal current flowing through a plate of metal such that they are at the same potential, and on being joined by a wire no current flows between them. Then in a magnetic field whose lines are normal to the plate a transverse current is found to flow between the two points considered. This current was measured by means of a Deprez-d'Arsonval galvanometer arranged as a voltmeter. From the same crystallised mass of metal three rectangular plates were cut, one normal to the principal crystallographic axis, whilst in the two others this axis was parallel respectively to the large and small sides. In the first sheet of metal examined the intensity of the chief longitudinal current was 1 amp., and the plate was put in the interior of a Dewar tube plunged in liquid air. The results are given by means of diagrams giving the values of the p.d.'s as functions of the magnetic field. There are two branches corresponding to the two opposite senses of the field. The effect is dissymmetric, as has been previously shown. From the author's experiments it appears that the effect is at first proportional to the field, then attains a maximum, diminishes, and *changes its sign* about 5900 gauss, at least for one direction of the lines of force. For the other direction the inversion only takes place when the field is made more intense. It has already been shown by Van Everdingen that in the case where the field is parallel to the crystallographic axis the Hall-effect may have a positive sense. At —190° C. the effect becomes extremely large. After the inversion which occurs with a feeble field the effect increases with great rapidity, and starting from 3500 gauss it follows a linear law, and *is positive in sense.* If there are drawn through the origin two straight lines parallel to the two straight lines into which the two branches of the curve become transformed, these two straight lines represent a first effect, positive in sense. The differences of the ordinates between each of these straight lines and the corresponding branch of the curve measure a second effect, negative in sense, which attains a saturation practically complete setting out from 3500 gauss. The curves may be otherwise decomposed, but the manner of doing so here stated appears the most logical, and it seems that the observed phenomenon is the superposition of the two phenomena of contrary sign; the first following a linear law, the second attaining a saturation-point. At —190° the negative effect becomes 8·5 and 10 times (according to the sense of the field) greater than at the ordinary temperature, but the positive effect increases much more (38 and 71 times), and becomes predominant. In the electronic theories it is supposed that the transport of electricity in solids takes place only by means of *negative* electrons, whilst the positive charges remain bound to matter which does not participate in the current. The Hall-effect ought then to follow a linear law. This is just what the author has observed; for one of the two effects only the sense is positive, whilst the theory indicates the opposite sense. As for the phenomenon which is in the sense foreseen, it follows an unexpected law (saturation). It has been found possible by J. J. Thomson to explain a positive Hall-effect on considering the influence of the field on the electrons at the moment when these are in the immediate neighbourhood of, or in the interior of, the molecules. But this positive sense should only hold good for magnetic bodies, whilst with Bi we have to do with the most diamagnetic metal. It cannot be said with certainty that one of the two effects is a consequence of diamagnetism, but the two opposed effects, one with saturation, the other with its variation proportional to the field, appear to have absolutely different natures. The occurrence of saturation in a field in proportion less as the temperature is lower suggests molecular orientation; but this is only an association of ideas, not an explanation. With plates cut parallel to the axis, except for the magnitude of the effect the conclusions are the same—the predominant phenomenon is positive in sense. These results must deeply affect present views of electric conductivity. J. J. S.

1449. *Origin of Terrestrial Magnetism.* **L. A. Bauer.** (Terrestrial Magnetism, 17. pp. 79–96, June, 1912.)—A continuation of the author's previous discussions [see Abstracts Nos. 998, 999, 1389 (1910); 1240 (1911)]. He considers in this paper the possible disturbing forces which, operating on a simple uniform magnetisation of the earth about some diameter (*e.g.*, the axis of rotation), could change it into the heterogeneous system actually observed. He calculates separately the position of the earth's axis of uniform magnetisation for 1885 from the magnetic elements of places within a series of zones of 10° width lying between 60° N. and 60° S., and the corresponding magnetic moment of the earth. He finds the inclination (θ) of the magnetic axis to the rotation axis greater for zones in the southern hemisphere than in the northern hemisphere. For parallels from 60° N. to the equator (θ) is practically constant at 9°, but in the southern hemisphere θ increases as we go southwards to 21° in 60° S. Moreover, the meridional plane of the magnetic axis moves steadily from its mean position for the entire zone, in the northern hemisphere in a direction contrary to that of the earth's rotation, and in the southern hemisphere in the same direction as the earth's rotation, as we go polewards. The value of the magnetic moment is a maximum for the equatorial belt. The figure obtained for the magnetic moment of the whole earth is therefore smaller the wider the equatorial band from which we draw our data, up to ± 60° latitude, the limit of the observations available. Assuming that we may extrapolate up to 90° N. and S., the average intensity of magnetisation of the earth comes out at 0·0788, nearly 5 per cent. less than the hitherto accepted value derived by the Gaussian analysis for the region 60° N. to 60° S. All these results would seem to indicate that the earth is merely an electromagnet. Assuming negative electric currents circulating inside the earth from west to east along parallels of latitude whose strength varies as the sine of the co-latitude, then, if the earth were not rotating the magnetic elements measured on the surface would be the same as those derived from a uniform magnetisation about the axis of rotation, the south magnetic pole being coincident with the north pole. But as the earth rotates, the currents may no longer follow strictly latitudinal paths, but may perhaps be turned by the earth's deflecting force so as to flow toward the equatorial regions from both sides to the equator. In this way, or by other action of the earth's centrifugal force, the author seeks to account for the increased apparent magnetisation in the equatorial regions mentioned above, and for the existence of the equatorial component of the earth's apparent magnetisation and especially the rapid variation in its magnitude from parallel to parallel. In short, the question arises, whether the two rectangular components of the magnetic moment combined may not form practically the magnetic system symmetrical about the axis of rotation which would exist if the earth did not rotate. An assymmetry about the equator appears to be due to effects similar to those resulting from the flow of electric currents across the vertical component of the earth's apparent magnetism. As the vertical component is directed oppositely in the two hemispheres, the effects are of opposite sign and hence the assymmetries: the effect would be additive in one hemisphere and subtractive in the opposite one. A. D. R.

1450. *Thermomagnetic Force of Metals.* **P. Senepa.** (Accad. Lincei, Atti, 21. pp. 58–58, July 14, 1912.)—The author deduces theoretically that the force M tending to rotate a Bi disc, suspended in a magnetic field, and heated at its centre or circumference, is equal to $m(T_0 - T_R)H^2$, where H is the intensity of the magnetic field $(T_0 - T_R)$ the difference in temperature between centre and circumference, and $m = b\mathrm{KUS}/[4 \log (\mathrm{R}_0/\mathrm{R})]$, b being the thickness of the disc, S the area of its surface, R the radius of the inner circle at the constant lower temperature, K its thermal conductivity, and U a constant, characteristic for the metal. Experiments with magnetic fields ranging from 1500 to 2000 units, and for varying differences of temperature, support the accuracy of the theory. A comparison of the values of U for different metals taking Bi as 1, gives the following results:—Sb, 0·054; Bi-Pb 66·6 %, 0·057; Bi-Pb 50 %, 0·045. [See Abstract No. 1089 (1911).] W. H. Si.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1451. *Electrolytic Effects of Continuous Currents on Living Plant Cells.* **F. Kövessi.** (Comptes Rendus, 155. pp. 63–66, July 1, 1912.)—The effects of the electric current on the germination and growth of plants cannot wholly be explained by electrolysis of the soil, heating by the current, change of the transpiration of the plants, &c. There seems to be a direct electric effect. When grains of corn are sown between sheet electrodes of Pt at 110 volts, yielding currents of 0·1 amp., they will not germinate nor develop, especially not near the electrodes; fresh grains afterwards placed in the same soil, without electrification, do not thrive well either. When the grains are simply placed on pure filter-paper and wetted with distilled water, K, Ca, Fe, &c., are found near the kathode, and acids (phosphoric, nitric, sulphuric, &c.) near the anode; albuminoids are also found in the water, whose resistance decreases. The membranes therefore lose, under the influence of continuous currents acting for days, their semi-permeable nature, and allow electrolytes and also albuminoids to escape. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1452. *Red Phosphorus.* **A. Stock, H. Schrader and E. Stamm.** (Ber. Deut. Chem. Gesell. 45. pp. 1514–1528, June 22, 1912. Chem. News, 106. p. 24, July 12, 1912. Abstract.)—Continuing previous researches, the authors find that ordinary red phosphorus is not a uniform substance, and that the conversion of colourless into red phosphorus is mainly due to the extreme violet of the visible spectrum. The temperature has little influence upon the conversion, but the higher the temperature the more red phosphorus will be in the resulting product. Phosphorus vapour is always colourless up to 1175° C. and is not affected by the light of the sun nor by the light of the quartz or mercury lamp. The conversion is effected in an exhausted bulb provided with a side tube, in which the vapour is condensed to a thin film which is then exposed to the radiations from the quartz lamp on its inner side. The cooling should be rapid. Red phosphorus begins to fume at 380°; its ignition temperature lies much higher than is generally stated; it is chemically different from colourless phosphorus, and the difference is not due to polymorphism; its condensation takes place independent of the presence of liquid, colourless phosphorus. H. B.

1453. *Devitrification of Silica Glass.* **W. Crookes.** (Roy. Soc., Proc. Ser. A. 86. pp. 406–408, April 25, 1912. Chem. News, 105. p. 205, May 3, 1912.)—A silica glass tube, perfectly transparent, 20 cm. long, 1 cm. diam., with a bulb at one end, was heated in an electric furnace to 1300°. After 24 hours it looked white and frosted. The tube had previously been exhausted, but some air had found its way into the tube. When the experiment was repeated, and the tube opened under mercury after 11 hours' heating, nearly 8 per cent. of the tube's capacity was found full of air. In a parallel experiment made with this exhausted bulb and a facsimile glass tube, kept in the cold after heating, the glass tube remained exhausted, but the silica tube became half filled with air in a few days. The devitrified silica appeared cracked all over with hexagonal outlines; this appearance was similar to that of a silica dish in which radium bromide had been evaporated. H. B.

1454. *Porous Metals.* **H. I. Hannover.** (Comptes Rendus, 154. pp. 1594–1597, June 10, 1912.)—The solidification of metallic alloys usually takes place over a somewhat extended range of temperature, during which period they are more or less plastic. If the alloys are subjected to the pressure of gas or oil, or are centrifugalised in this state, the still fluid metal can be removed, leaving behind a porous metallic mass. In this way the author suggests the preparation of plates for accumulators, bearings permeable to lubricating oil, and rods of tin impregnated with rosin for soldering. F. C. A. H. L.

1455. *Influence of Impurities on Solubility of Aluminium.* **E. Kohn-Abrest** and **Rivera-Maltes.** (Comptes Rendus, 154. pp. 1600–1602, June 10, 1912.)—The experiments show that the solubility of Al is not influenced by the small proportions of Fe and Si generally found in commercial Al. The presence of 0·1 per cent. of Cu was found to prevent any solubility in water. E. M.

1456. *Gases given off from Aluminium.* **M. Guichard** and **P. R. Jourdain.** (Comptes Rendus, 155. pp. 160–163, July 8, 1912.)—The authors have examined the composition of the small quantities of gas given off by heating aluminium which has been in use for different periods. E. M.

1457. *Further Experiments on the Critical Point at 470° C. in Copper-Zinc Alloys.* **H. C. H. Carpenter.** (Inst. of Metals, Journ. 7. pp. 70–88; Discussion and Correspondence, pp. 89–104, 1912. Engineering, 93. pp. 265–268, Feb. 23, 1912. Rev. de Métallurgie, 9. pp. 261–268, April, 1912.)—This contains the results of further experimental work on the critical point at 470° in copper-zinc alloys. [See Abstracts Nos. 1264 (1911), also 2118 (1907.)] The interpretation previously advanced was that at 470° on cooling, the β constituent, in alloys containing from 63 to 40 per cent. Cu, splits up into an intimate mixture of α and γ; on heating the reverse change takes place. From the present work it is concluded that this β constituent is to be regarded below 470° as an extremely minute and uniform complex of α and γ particles. Its structural stability is so remarkable that after 6 weeks' annealing at 445° no appreciable coalescence of these particles can be observed in an alloy of exactly the eutectoid composition. When, however, a few crystallites, either of α and γ, are initially present, on annealing at 445° this stability is comparatively easily destroyed. These crystallites constitute nuclei for the deposition of α and γ as the case may be. The structural stability of the eutectoid alloy can be so much diminished by the presence of 4 per cent. Al, that after 2 days' annealing at 445° it undergoes the typical lamellar inversion such as is shown by the iron—iron-carbide eutectoid (pearlite). C. O. B.

1458. *Behaviour of Certain Alloys when Heated in Vacuo.* **T. Turner.** (Inst. of Metals, Journ. 7. pp. 105–113; Discussion and Correspondence, pp. 114–122, 1912. Engineering, 93. pp. 301–302, March 1, 1912. Mech. Eng. 29. pp. 106–107, Jan. 26, 1912.)—Pure brass can be quantitatively separated into its constituents by melting *in vacuo*, the zinc distilling and condensing in the cooler parts of the tube while the whole of the copper remains behind, providing the heating is not too prolonged and the temperature does not rise above 1200° C. A sample of "poisoned brass," containing Cu 72·58, Zn 11·65, Pb 7·11, Sn 5·52, Fe 2·00, Al 0·75, As 0·09, and Mn 0·06 per cent., lost the whole of the Zn, Pb, As, and about 0·2 per cent. Sn when heated *in vacuo* to 1200° C. Experiments on a larger scale, using about 150 gm. 70 : 30 brass in a properly lagged vacuum desiccator showed that the rate of loss of Zn was about 1 per cent. per min. These experiments indicate that copper could be refined to a considerable degree by melting *in vacuo*, the impurities being recovered at the same time. Further experiments were made by heating hard zinc containing 4·71 % Fe and 0·81 % Pb at different temperatures *in vacuo*. At 500° C. the whole of the Fe is left in the residue, and as a method of refining Zn the process should be remunerative, since the fuel consumption is low and the loss of Zn nil. Determinations of the temperature at which the evolution of Zn vapour takes place *in vacuo* showed that Zn begins to give off vapour at 370° C., 60 : 40 brass at 520° C., and 70 : 30 brass at 550° C. By exposing Zn and Cu in the same evacuated hard-glass tube to a temperature of 375° to 380° C. it was shown the Cu absorbs the Zn-vapour and becomes coated with a firmly adherent layer of brass. Prolonged experiments showed that Zn is volatile *in vacuo* at a temperature even as low as 184° C.

F. C. A. H. L.

1459. *Behaviour of Alloys when Heated in Vacuo.* **C. R. Groves** and **T. Turner.** (Chem. Soc., Journ. 101. pp. 585–591, April, 1912.)—This is a continuation of the work recently published by Turner [see preceding Abstract] on the effect of heating alloys in a vacuum. The range of temperature employed extended from 350° to 1200°. Within this range of temperature and time employed in the experiments the behaviour of alloys permits of their classification into the following five groups:—(1) The metals are non-volatile, and the alloy is not altered in weight. To this group belong Cu-Al, Cu-Ni, Cu-Sn, and Cu-Fe series. (2) The volatile metal or metals are completely removed, and a quantitative separation results; examples: Cu-Bi, Cu-Pb, Cu-Zn, Fe-Zn, and Pb-Sn series. (3) Any excess of volatile metal is removed, and a chemical compound remains; examples: Au-Zn, Cu-Sb, Au-Cd, and Mg-Zn series. (4) Any excess of volatile metal is removed, but the residue is not a chemical compound; to this group belongs the Cu-As series. (5) The metals composing the alloy volatilise together, their relative proportions being, in part, dependent on the temperature employed; examples: Ag-Zn, Ag-Pb, Pb-Zn series. C. O. B.

1460. *Alloys of Platinum with Aluminium.* **Chouriguine.** (Comptes Rendus, 155. pp. 156–158, July 8, 1912.)—Covering the Al with a film of LiCl to prevent oxidation, by immersion in dilute LiCl solution, and heating the Al with Pt in an electric resistance furnace, the author has prepared and determined the thermal properties of alloys containing from 5 to 90 per cent. Al. A eutectic point is observed at 639° C., corresponding to 9 per cent. Pt, but the only definite compound isolated is crystalline $PtAl_3$. The alloys containing from 70 to 90 per cent. Pt are yellow, the others white.

W. H. St.

1461. *Influence of Oxygen on Copper containing Arsenic or Antimony.* **R. H. Greaves.** (Inst. of Metals, Journ. 7. pp. 218–238; Discussion and Correspondence, pp. 239–245, 1912. Engineering, 93. pp. 196–199, Feb. 9, 1912. Mech. Eng. 29. pp. 176–179, Feb. 9, 1912.)—Gives the results of an investigation on the influence of oxygen on various mechanical and physical properties of samples of copper containing varying proportions of As and Sb. The appearance of the ingots cast varies somewhat: they showed in general a longitudinal depression on the surface, but in some cases were flat. With one exception all the flat ingots obtained with the arsenical series contained from 0·05 to 0·10 % oxygen with 0·08 to 0·3 % As. Alloys whose content of O or As exceeded these limits showed a depression. All the alloys containing 0·04 to 0·4 % Sb and 0·1 to 0·46 % O showed a depression. As a result of rolling tests, it is shown that as As increases up to 0·5 % the metal may take up more and more oxygen without suffering deterioration in its capacity for rolling. This quantity of oxygen rises from about 0·05 to 0·2 as As increases from 0 to 0·2, then more slowly to about 0·28 as the As increases to 0·5 %. Above the limits indicated, oxygen causes a rapid deterioration of the metal, which becomes cold short. Sb, up to 0·4 % reduces the cold shortness of pure "dry" copper. Results of wire-drawing tests are also given. From the tensile tests given it appears that for metals in the cast state containing a constant amount of oxygen, there is a slight rise in tensile strength and more marked improvement in the elongation as the As increases. With a constant percentage of As there is very little change in the tensile strength as the oxygen increases from 0·17 to 0·4 % but the elongation falls off rapidly. Hardness tests were taken by means of the Shore scleroscope, and it was found that As or Sb hardens pure Cu and the effect of either on Cu containing oxygen was first to diminish and then to increase its hardness. Electrical conductivity tests showed that in every case in the As series the conductivity is less when oxygen is present, whereas in the Sb series the effect of oxygen is to raise the conductivity. The effect of oxygen on the microstructure is also given and illustrated. C. O. B.

1462. *Effect of Vibration on the Structure of Alloys.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 32. 3. pp. 315-320, 1911–1912.)—The belief that shock and vibration cause crystallisation of a metal is very widely held, and this view would appear to be a reasonable one, since there is a tendency in a mass of uniform metal for the crystals to assume a parallel orientation, so that shock should promote crystal growth by setting up molecular agitation. In order to investigate this point the author has made some preliminary experiments by agitating small chill-cast sections (⅜ in. cubes) of 70 : 30 brass, 10 % Sn, 90 % Cu alloy, and an alloy of 95 % Al and 5 % Zn in a wooden box (5 × 5 × 7 in.) revolving at 30 revs. per min. The original idea of imparting vibration without distortion was not attained, several of the specimens (the zinc alloys) showing considerable wear and distortion in their surface layers. Subsequent microscopic examination, particularly of deeply etched specimens under low magnification, shows a distinct increase in grain size after ¾ million revolutions. The rise in temperature in the box did not exceed 1 deg. F. and a local rise of more than 10 deg. C. is unlikely. Moreover, the distorted specimens did not show any further growth after 3 years, so that the results of these preliminary experiments, though not conclusive, would indicate that vibration was the chief factor in the growth of the structure.

F. C. A. H. L.

1463. *Chilling and Hardening of Cast Iron.* **T. D. West.** (Amer. Soc. Mech. Engin., Journ. 34. pp. 837–862, June, 1912. Engineering, 94. pp. 28–32, July 5, 1912.)—Gives the results of experimental work on the chilling and hardening of cast iron, and describes the author's method of obtaining an inside chill by mechanical means. This method consists in chilling the casting in water as soon as sufficient has solidified on the outside to enable the casting to withstand the pressure of the tongs used in its removal. The actions that take place and the conditions that exist during the process of chilling are summarised as follows :—(*a*) Iron is chilled prior to any formation of graphite. A chill may be made harder by continuing to cool it while the adjoining metal is still in a semi-molten state or very hot, as by this action any backward annealing is retarded. (*b*) Under like conditions, the lower the Si and the higher the S and C, the deeper the chill. (*c*) Under like conditions, the chill will be deeper, the smaller the area of the cross-section to be chilled. (*d*) Under like conditions, the less the thickness in the chiller below what can be utilised, the less the chill in the casting. (*e*) The longer the casting remains in close contact with its chiller while the metal is in a chillable state, the deeper the chill. (*f*) The hotter the metal the deeper the chill, and the greater the chillable nature of the metal, the more pronounced this effect. (*g*) Not all grades of iron are chillable. It requires, as a rule for iron of general carbon, less than 2 per cent. of Si and above 0·06 S. The results of much experimental work on details of chilling and hardening processes are given, including results showing the hardening of a chilled casting when hot by impingement of air against its surface, the relative efficiency of warm and cold chillers, the softening effect of annealing chilled iron, the efficiency of different thicknesses of chillers, and the efficiency of different metals as chillers. The results of tests on the heat conductivity of sand, iron, and air are also given, and chilling experiments with air under pressure show its superiority over metal chillers. C. O. B.

1464. *Influence of Tin and Lead on the Microstructure of Brass.* **F. Johnson.** (Inst. of Metals, Journ. 7. pp. 201–208; Discussion and Correspondence, pp. 9–17, 1912. Engineering, 93. pp. 361–362, March 15, 1912. Mech. Eng. 29. pp. 167–169, Feb. 9, 1912.)—As a result of microscopic examination of brass containing Sn, it is found that this metal is only slightly soluble in the α phase of the degree of concentration existing in 70 : 30 alloys as cast, separating out as $SnCu_4$. Rolling and annealing help it to pass into solution. Tin is, however, readily soluble as $SnCu_4$ in the β phase as contained in alloys of naval brass and Muntz metal type, even in the cast condition. Lead has been shown to exist in the free state in brass as more or less rounded particles scattered through the crystals. The influence of Pb and Sn together was examined in order to investigate the reticulated structure, stated by H. Louis to be caused by the presence of these two metals [see Abstract No. 839B (1911)]. As a result of this investigation it was found that the "reticulations," caused by the presence of Sn in a brass, in which the ratio Cu to Zn is 2 : 1 have no structural relations with any Pb which may be present, the latter existing in the free state. This is probably true of all α brasses. The reticulations are due to the decomposition of $SnCu_4$ from the β constituent, which is insufficient to retain it in solid solution. The author points out that the experimental work described explains why it is advisable in works practice to thoroughly anneal castings of Cu 70, Zn 29, Sn 1 and Cu 62, Zn 37, Sn 1 compositions before subjecting them to mechanical treatment, in order that the brittle tin compound may pass into solution; and also to allow materials made of naval brass, Cu 62, Zn 37, Sn 1, to cool slowly after annealing. C. O. B.

1465. *Compounds of Iron and Zinc.* **E. Vigoroux, F. Ducelliez** and **A. Bourbon.** (Bull. Soc. Chim. de France, 11–12, No. 10, 1912. Chem. News, 106. p. 36, July 19, 1912. Abstract.)—The alloys of these two metals have been studied by electrical methods, the results of which confirm the existence of the compounds $FeZn_7$ and $FeZn_3$ discovered thermally by Vegesack. $FeZn_7$ has been isolated in the form of small non-magnetic crystals, by the action of cold acetic acid on the alloys. The existence of the compounds Fe_3Zn and Fe_3Zn also appears probable. F. C. A. H. L.

1466. *The Reduction of Oxide of Iron and Gas Producers.* **H. le Chatelier.** (Rev. de Métallurgie, 9. pp. 513–531, July, 1912.)—The author discusses the chemical physics of the thermal dissociation and the reduction of oxide of iron by carbon, manganese, and carbon monoxide. Such practical processes as casting, cementation, and the production of malleable iron are dealt with. From a similar point of view the gas producer is considered, the object of the lecture being to show how purely scientific knowledge can be utilised practically. F. C. A. H. L.

1467. *Structure of some Rough Forgings. Relation between Mechanical Properties and the Widmanstätten Structure.* **A. Portevin** and **V. Bernard.** (Rev. de Métallurgie, 9. pp. 544–550, July, 1912.)—Belaiew has shown that the

conditions for the formation of Widmanstätten figures in carbon steels are: (1) Exposure for a sufficient length of time to a temperature in the γ solid solution region, and (2) rapid cooling through the region in which ferrite and cementite are isolated. These conditions may occur after the operation of forging and rolling, and the authors have observed the development of Widmanstätten figures in forged steels containing between 0·15 and 0·35 per cent. carbon, some of which have broken in service. Tensile and shock tests show that such steels have mechanical properties which are inferior to those possessed by the same steels after heat treatment, and, in fact, there appears to be a direct relationship between the Widmanstätten structure and fragility. The authors point out the advisability of heat treating (quenching and tempering) all steels after rough forging.
F. C. A. H. L.

1468. *Iron-Carbon System.* **A. Smits.** (Zeitschr. Elektrochem. 18. pp. 362–368, May 15, 1912.)—The author dissents from the conclusions arrived at by Ruff [Abstract No. 1619 (1911)], and has examined the results from a thermodynamical point of view. There is no evidence for the existence of the carbide Fe_3C, but Ruff's results do point either to the existence of new stable carbides FeC and FeC_2, or of two new modifications of graphite.
F. C. A. H. L.

1469. *Formation of Osmondite in Hypoeutectic Steels.* **J. Calian.** (Metallurgie, 9. pp. 392–396, June 22, 1912.)—Heyn and Bauer [Abstract No. 1483 (1906)] showed that the transformation—martensite ⟶ pearlite in hardened tool-steels is not continuous, but that the well-defined intermediate product, osmondite, is obtained by tempering at 400° C. Their methods, coupled with microscopic examination, have been applied by the author to steels containing 0·42 to 1·02 per cent. carbon, and the results show that in hypoeutectoid steels martensite passes through the stages: troostite, osmondite, and sorbite in its transformation to pearlite. Osmondite, however, is not formed at a constant temperature, but may be produced at any temperature between 300° and 500° C. The osmonditic structure depends rather upon the molecular configuration and composition of the material than upon the amount of free carbon and carbide residue obtained. Consequently the carbide residue at 400° C. increases as the carbon-content decreases. F. C. A. H. L.

1470. *The Upward Concentration of Kish by Flotation.* **H. M. Howe.** (Metallurgical and Chem. Engin. 10. pp. 359–360, June, 1912.)—It would appear from Goerens' work [Abstract No. 912 (1907)] that kish is identical with primary graphite, and the author has shown that in a slowly-cooled ingot of cast iron there is a distinct concentration of graphite towards the top. That this concentration is not due to natural segregation is shown by the fact that the graphite-content is highest at the top of the ingot and not at the bottom of the pipe, which is the last to solidify. The strong curvature of the graphite points to its being idiomorphic, and not pseudomorphic, after the straight primary cementite crystals. F. C. A. H. L.

1471. *Osmotic Pressure of Cane-sugar Solutions at High Temperatures.* **H. N. Morse, W. W. Holland, C. N. Myers, G. Cash and J. B. Zinn.** (Amer. Chem. Journ. 48. pp. 29–94, July, 1911.)—It has been shown previously that the ratio of osmotic pressure to gas pressure for aqueous solutions of cane-sugar is constant over the range from 0° to 25° for concentrations from 0·1 to 1·0 normal. But the ratio is not unity in any case, the excess ranging from 6 per cent. at 0·2 to 11 per cent. at 1·0 normal. Further experiments have now shown that the ratios diminish at higher temperatures, and that the osmotic pressure and gas pressure become equal at 30° for 0·1 normal, 50° for 0·2 normal, 60° for 0·3 and 0·4 normal, 70° for 0·5, 0·6, and 0·7 normal, and 80° for 0·8, 0·9, and 1·0 normal concentration. T. M. L.

1472. *Physico-chemical Determinations at High Pressures by Optical Methods.* **W. Wahl.** (Roy. Soc., Phil. Trans. 212. pp. 117–148, July 17, 1912.)—An apparatus is described in which materials can be compressed up to 4000 atmos. and inspected through glass windows. These windows, which are the most important feature of the apparatus, were truncated cones 15 mm. thick, and tapering from 10 to 7 mm. diam. Instead of being compressed during working into a conical socket, they were arranged with the wider ends outwards and resting upon perforated washers of lead-foil supported by the steel structure of the compression bomb: in order to make sound joints a hollow truncated cone was drilled in the steel, tapering in the opposite direction to the glass cone, and the space between the two cones was filled with a plastic material ("galalith," or fibre), which was kept tightly in place by the pressure in the bomb. The pressures were produced by hand-worked screws, and were measured by calibrated pressure-gauges. A description is given of the use of the apparatus to determine the diagrams of state of carbon tetrabromide and of dibromopropionic acid. T. M. L.

1473. *Dissociation Pressures of Sodium and Potassium Hydrides.* **F. G. Keyes.** (Amer. Chem. Soc., Journ. 34. pp. 779–788, June, 1912.)—The dissociation pressures of sodium and potassium hydrides were measured and found to be as follows:—

Temp., t =	290	300	310	320	330	340	350	360	370	380	390	400	410° C.
NaH, p =	5·01	8·02	12·42	18·62	28·45	41·69	61·94	89·13	128·83	181·97	257·0	354·8 mm.	
KH, p =		7·31	11·49	17·62	26·6	39·8	58·6	85·9	124·2	177·0	253·5	259·7	497·73 mm.

$$\text{For NaH}: \log_{10} p = -5700/T + 2{\cdot}5 \log_{10} T + 8{\cdot}956.$$

$$\text{For KH}: \log_{10} p = -5850/T + 2{\cdot}6 \log_{10} T + 3{\cdot}895.$$

The vapour-pressure equations for liquid Na and K were calculated from: (1) the boiling-points of these substances; (2) their heats of vaporisation, derived from Trouton's rule (assuming the same constant as for mercury); and (3) the heat capacities of the liquids and the vapour. These equations are—

$$\text{For Na}: \log p = -6200/T - 1{\cdot}35 \log T + 12{\cdot}4.$$

$$\text{For K}: \log p = -6000/T - 0{\cdot}40 \log T - 0{\cdot}0008T + 10{\cdot}73.$$

The heat of reaction at ordinary temperatures was calculated from the measurements, and found to be 13,860 cals. per formula-weight of sodium hydride (NaH) and 14,240 cals. per formula-weight of potassium hydride (KH). T. M. L.

1474. *Dissociation of Hydrogen into Atoms.* **I. Langmuir.** (Amer. Chem. Soc., Journ. 34. pp. 860–877, July, 1912.)—The energy loss from wires heated in various gases can be calculated by simple equations. For nitrogen and mercury vapour the calculated results agree well with experiment up to 3500° K. With air and CO_2 similar agreement was obtained up to the melting-point of Pt. In the case of hydrogen, however, there is agreement only up to about 2100° K. Above that the energy loss increases extremely rapidly, so that at 3300° it is four or five times the calculated value. This was explained by assuming that hydrogen at very high temperatures is dissociated into atoms. In order to interpret these results the theory of the heat conductivity of a dissociating gas was developed ; the heat of the reaction and the degree of dissociation at various temperatures was calculated and was found to agree well with van't Hoff's equation. Experiments at low pressures proved that the phenomenon is a true dissociation, which follows the law of mass action, and that the volume of the dissociation products is approximately twice the volume of the original hydrogen, the dissociation taking place according to the equation $H_2 = 2H$. The heat of reaction at constant volume for $2H = H_2$ is 550,000 joules, or 130,000 cals. At constant pressure it would be approximately 575,000 joules, or 136,000 cals., at 3000° K. The degree of dissociation at any temperature T, is given by the equation—

$$\log \frac{p_1}{\sqrt{P - p_1}} = 2{\cdot}665 - \frac{14400}{T} + \frac{1}{2} \log T,$$

where p_1 is the partial pressure of the hydrogen atoms (in atmos.), and P the total pressure (in atmos.). From this equation the free energy of formation of hydrogen molecules from atoms can be calculated.

The following table gives the degree of dissociation (p_1) of hydrogen at 1 atmo. pressure at various (absolute) temperatures.

DEGREE OF DISSOCIATION OF HYDROGEN AT ATMOSPHERIC PRESSURE.

T. °K.	p_1 atmo.	T. °K.	p_1 atmo.
293° (20° C.)	$5{\cdot}4 \times 10^{-46}$	2900°	0·236
		3100	0·441
500	$1{\cdot}7 \times 10^{-25}$	3300	0·666
1000	$5{\cdot}8 \times 10^{-11}$	3500	0·840
1500	$4{\cdot}49 \times 10^{-6}$	3700	0·933
2000	$1{\cdot}30 \times 10^{-3}$	3900	0·973
2300	0·0121	4100	0·988
2500	0·0394	4500	0·9962
2700	0·106	5000	0·99981

Nitrogen, even at 3500° K, is not perceptibly dissociated at atmospheric pressure ; that is, its dissociation does not exceed 5 per cent. T. M. L.

1475. *Electrolytic Estimation of Manganese and its Separation from Iron.* **H. Golblum** and **Miss H. Gunther.** (Comptes Rendus, 155. pp. 166–168, July 8, 1912.)—Classen has shown that, from a solution containing Fe and Mn, the whole of the former metal may be deposited electrolytically on the kathode, while no anodic precipitation of the Mn occurs. With a solution containing these metals as sulphates in presence of ammonium oxalate and kept vigorously stirred by means of a rotating electrode, the authors find that it is possible to precipitate the Mn quantitatively (as MnO_2) on the anode, a very small proportion of the iron being at the same time deposited on the kathode. When a current of 2 amps. at 3 volts is used, and the kathode makes 700 revs. per min., 0·1 gm. of the Mn deposited contains 0·2–0·5 mgm. of Fe, but if the current density is doubled and the revolutions are increased to 650, more than 1 mgm. of Fe may be precipitated with the Mn. This amount of iron may be readily determined colorimetrically, and is added to the quantity ascertained by subsequent electrolysis of the iron solution.

T. H. P.